

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK

H. L. Aldrich, President and Treasurer
Assoc. Member of Council, Soc. N. A. and M. E.

George Slate, Vice-President
E. L. Sumner, Secretary

31 CHRISTOPHER ST., LONDON, E. C.

E. J. P. Benn, Director and Publisher
Associate Inst. N. A.

Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

Vol. XX

DECEMBER, 1915

No. 12

Cause of Loss of the F-4

From facts established by the investigation of the board of naval officers appointed to determine the cause of the loss of the United States submarine F-4, which was sunk outside of Honolulu harbor on March 25, it has been concluded that the primary cause of this disaster was the corroded condition of the lead lining, and of certain rivets, in the port wall of the forward steel battery tank. Apparently unknown to the commanding officer, the vessel acquired some negative buoyancy forward of the center of gravity through the leaky rivets in the wall of the battery tank, causing the boat to dive. Secondary causes of the disaster were laid to the poor diving qualities of the vessel and the consequent failure of the boat to respond promptly to measures taken to bring her to the surface. Accepting corrosion as the primary cause of the disaster, it apparently indicates a lack of care and inspection of the vessel. The likelihood of corrosion is always present in all vessels and machinery, and the only sure prevention of this is regular and minute inspection, with thorough cleaning and overhaul.

Hog and Sag of Merchant Vessels

Considerable data have been brought out at recent meetings of the Society of Naval Architects and Marine Engineers regarding the sagging and hogging of various types of merchant and naval vessels. The change of shape of single-deck vessels as affected by the distribution of loads in the structure of the vessel seem to have been measured with considerable exactness. Much of the data has been taken from government colliers, while the vessels were on the stocks, immediately after launching, when the machinery was installed, when in dock, before loading and when fully loaded. When fully loaded these vessels invariably sagged by amounts varying from 2 to nearly 4 inches, the difference in the amount of sag in different vessels being accounted for by the unequal distribution of the cargo. While the sagging of long single-deck cargo-carrying vessels is properly accounted for by the distribution of the load, the reverse effect of the hogging of the vessel, due to the differences in temperature between the upper part of the vessel exposed to the warm air and the bottom of the vessel exposed to the cold water, does not seem to have been determined with the same exactness. Extreme cases of this are reported on the

Great Lakes, where the long single-deck cargo vessels, after being loaded to the proper draft at the beginning of a voyage, have been found to hog to such an extent during the voyage that the draft at the bow and stern has been increased by nearly 6 inches, making it impossible for the vessel to enter the canal locks without lightening the load. This difficulty, however, has been overcome in a thoroughly practical manner by playing hose on the deck of the vessel for some time when approaching the canal locks, the result being that the deck, having been heated by exposure to the sun, is cooled and the vessel straightens itself out, coming back to the draft at which she was originally loaded.

Bids for New Battleships

The bids for the United States battleships Nos. 43 and 44, which were opened by the Navy Department on November 17, have caused much discussion on account of the fact that all of the bids submitted by private shipyards were higher than any estimates submitted by government navy yards. As we have pointed out before, it is practically impossible to reconcile bids of the private shipbuilders and the estimates from government navy yards on account of certain factors which are included in one case and which are practically ignored in the other. The result in this case has been that preparations are now being made, not only to build these two battleships in navy yards, but also to bring about the equipment of as many navy yards as Congress can be induced to provide for, so that a large proportion of the vessels to be authorized by the next Congress can be constructed by the government. In submitting their bids, the private shipbuilders incorporated certain stipulations which in all fairness should be granted by the government. These stipulations proposed that the government should waive certain requirements in contracts heretofore executed, or should stand the expense of certain equipments and incidentals heretofore paid for by the contractors. These items include the contractors' bond, insurance of the vessel during construction, the cost of preliminary trials, and changes in constructional features made after the signing of the contracts. All of these items have had an important bearing on the relative costs of construction in private yards and in government navy yards. To secure a just comparison of the bids, these stipulations should be carefully considered. If they were

granted, the preliminary trials of naval vessels, which were paid for heretofore by the contractors, would be eliminated and the speed of the vessels would be determined on the basis of their performance after six months' test.

Final Report of the Bulkhead Committee

One of the most important services to the shipbuilding industry that has been undertaken in recent years has just been completed by the publication of the second and final report of the Departmental Committee on Bulkheads and Watertight Compartments. This report deals with the subdivision of channel, coasting and river steamers and supplements the committee's first report, issued in January, which covered seagoing vessels. So far as the underlying principles are concerned regarding floodable lengths of the ships and the method of finding the permissible length of compartment by multiplying the floodable length by a factor of subdivision, the same methods are applied in both cases, with exceptions, of course, for various classes of vessel covered in the second report. The fundamental principle upon which these recommendations are based involves the use of cross curves and other data by means of which in ordinary cases flooding curves for any permeability can be obtained for a vessel of given block coefficient, longitudinal distribution of displacement, freeboard and sheer ratios. By multiplying the ordinate of the flooding curve at any point in the length of the ship by the factor of subdivision recommended for the particular length and type of ship the maximum permissible length is found which a watertight compartment can have whose center of longitudinal section is at this point.

The various classes of vessels covered by the second report are grouped in five general classes as follows: passenger steamers plying within home trade limits, passenger steamers plying on short excursions along the coast during daylight and in fine weather between April 1 and October 31, passenger steamers plying within partially smooth-water limits, passenger steamers plying in smooth waters either in estuaries and lakes or on rivers and canals, and cargo steamers, either foreign-going or home trade. As these classes cannot be clearly defined on account of the variations in sizes and services for particular vessels, exceptions to the general recommendations must necessarily be recognized, and undoubtedly the requirements of exceptional vessels will be carefully considered without unduly hampering the shipowners and builders.

An important provision in the line of safety is made as regards the requirements for pumping machinery. In vessels under 250 feet long, in addition to the ordinary bilge pumps on the main engine, or the equivalent engine-room pump, one bilge pump independent of the main engine must be provided, and also one other pump of the Downton or cranked type. In vessels between 250 and under 300 feet an additional Downton or cranked pump must be carried. In vessels 300 feet long and over, two power bilge pumps independent of the main engines must

be installed. The piping must be arranged so that each of these extra pumps can draw water from all of the compartments at the rate of 400 feet per minute. Where two extra power pumps are required the source of power for one of them should be independent of the main propelling plant and situated above the bulkhead deck.

Lloyd's Annual Report

In spite of the losses to merchant shipping since the present war began, the business of Lloyd's Register of Shipping does not seem to have been adversely affected. On the other hand, in its annual report for the year ending June 30, 1915, the tonnage of vessels classed by the society during the year is shown to have been 300,000 tons in excess of that classed during the previous year. The vessels actually completed during the year numbered 571 of 1,295,623 tons, of which about 67 percent was built for the British Empire and about 33 percent for other countries. This favorable showing is explained by the fact that while merchant shipbuilding in all the belligerent countries, and especially in the United Kingdom, has necessarily fallen off on account of the great demands for naval construction, nevertheless the lessened production of merchant vessels in those countries has given an impetus to the industry elsewhere. In other words, the actual volume of tonnage which is in hand throughout the world is not materially different from what it was a year ago, but it is distributed in different proportions among the several shipbuilding countries, a large share of the work going to the United States.

Only seven vessels of over 10,000 tons were classed by Lloyd's during the year, the two largest being the *Orbita* of 15,678 tons for the Pacific Steam Navigation Company and the *Transylvania* of 14,315 tons for the Anchor Line. Among the special structural features in vessels built or building during the year, mention is made of two steamers of the *Monitor* type, in which the side plating is worked in a corrugated form, and also of a new form of watertight bulkhead in which the necessary strength and stiffness are obtained by working the plating in a corrugated form. The Isherwood system of longitudinal framing continues to be used extensively. In all, over 300 vessels with this type of framing, totaling 1,675,000 gross tons, have so far been built. As a consequence of the increasing demand for vessels carrying oil in bulk, which has been intensified since the beginning of the war, several ordinary cargo vessels of various types have been converted into tank steamers. In some cases this has been accomplished by placing circular tanks in the holds of ordinary cargo steamers.

In the year's progress in the development of propelling machinery for merchant vessels, the steadily increasing use of steam turbines is noticeable, especially in connection with reduction gearing. Several large vessels were built during the year in which geared turbine machinery was installed. As compared with an all-turbine installation, however, attention is directed to the advantage pos-

sessed by combination reciprocating and turbine machinery, in that the machinery can be worked at reduced speed with practically the same efficiency as at full power, because the supply of steam to the engine can be reduced in quantity by "linking up" without at the same time reducing the pressure. On the other hand, with ordinary steam turbines, which always present the same area of opening for the admission of steam, the quantity of steam entering the engine can be reduced only by reducing the pressure. Two vessels are being built in the United States, however, in which Curtis turbines are to be installed, in which the admission of the high-pressure steam does not take place around the whole of the circumference, but the area of opening can be varied between certain limits to regulate the steam supply.

There is also another special feature in which these turbines differ from other installations. In order to obtain reasonable efficiency in the steam turbine the peripheral velocity of the blades must bear a certain proportion to the velocity of the steam flowing past them. This velocity is determined by the difference of pressure on the two sides of the various rows of blades. Where many rows of blades are arranged the fall of pressure on each row is less than where fewer rows are employed, consequently the velocity of the steam is also less where many rows of blades are used, and therefore lower speeds of the engine are admissible. In the Curtis turbine comparatively few rows of blades are used. The drop of pressure past each row is large and, consequently, the velocity of the steam past the blades is high. This necessitates a very high speed of rotation and, in the installations referred to, the turbine speed at full power will be above 3,500 revolutions per minute. This high speed will be reduced to about 90 revolutions per minute at the propeller shaft by means of a double set of gearing. The turbine shaft is coupled to a pinion with helical teeth, which gears into two wheels, each on separate shafts, which turn at about 700 revolutions per minute, each of these shafts transmitting one-half of the power. The pinions on these shafts, in turn, gear into a double steel wheel on the main propeller shaft, causing a further reduction of speed to about 90 revolutions per minute. This arrangement provides for a certain amount of flexibility and elasticity by means of spherical seated bearings for the gear shafts. The extremely high speed of rotation of the turbine and the small number of rows of blades permit this part of the propelling machinery being made much lighter than would be the case with corresponding parts in an ordinary steam turbine of the same power for direct drive.

Although progress in the commercial development of the Diesel engine for marine work has been seriously retarded by the war, nevertheless during the past year several new vessels have been fitted with Diesel engines, and at present Lloyd's has classed 38 ships fitted with this type of machinery. Of these, the East Asiatic Company, of Copenhagen, owns ten, the Nederlandsch-Indische Tankstoomboot Maatschappij eight, and the Rederi Aktiebolaget Nordstjernan six. Thirteen of these vessels were built

and engined by Burmeister & Wain, of Copenhagen, and eleven were engined by the Werkspoor Company, of Amsterdam. A two-stroke cycle Diesel engine, in which the cylinder contains two pistons, operating in opposite directions, has been developed by Messrs. W. Doxford & Sons, Ltd., with apparently satisfactory results. In this engine the effective stroke is the sum of the strokes of both pistons and the total height required for the engine is less in proportion to the length of the stroke than that of any other type. This type of engine is especially suitable for cases where the height is restricted and where long strokes are desired in order to obtain a reasonably high piston speed without an undue number of revolutions.

Preparedness for Defense

At a recent meeting of the New York Commandery of the Society of American Wars, attended by officers of the United States army and navy, a committee was appointed to secure the co-operation of all other patriotic societies and kindred organizations of the United States for a united demand for such legislation by Congress as will provide ample and adequate means of national defense both on land and sea. It goes without saying that this demand is made not with any idea of so-called "militarism" or the acquisition of new territory by force of arms, but for the purpose of guaranteeing the citizens of the United States the security and governmental protection which by its strength will discourage any plan of invasion by a foreign nation, and which at the same time will be the best guarantee of peace in the future.

This movement, as well as all others which tend to arouse the people of the nation and in turn their representatives in Congress to a full appreciation of the vital need of more adequate preparedness for defense, deserves unqualified support. For the adequate defense of a country situated like the United States, however, there can be no question as to the importance above everything else of a strong and efficient navy, rather than a big army. The interests of the United States are not centered within its own boundaries. They extend to every part of the world, and to secure the rights of American citizens on the high seas and in foreign countries no force is more potent than a strong and efficient navy. Few will now dispute the fact that if the United States had had a dozen more battleships at the time of its differences with Spain, eighteen years ago, there would have been no so-called Spanish-American War, and that the cost of those battleships would have been only a small fraction of the cost of the war. To profit by such a costly lesson, the first demand of the citizens of the United States for better protection should be for increased naval strength—and by increased naval strength we mean not only a bigger and more powerful navy, but adequate reserves of men, munitions and supplies and the enrollment of engineers, naval architects, shipbuilders and all men who, by training, skill and experience, can contribute to the upbuilding and maintenance of the navy in cases of emergency.

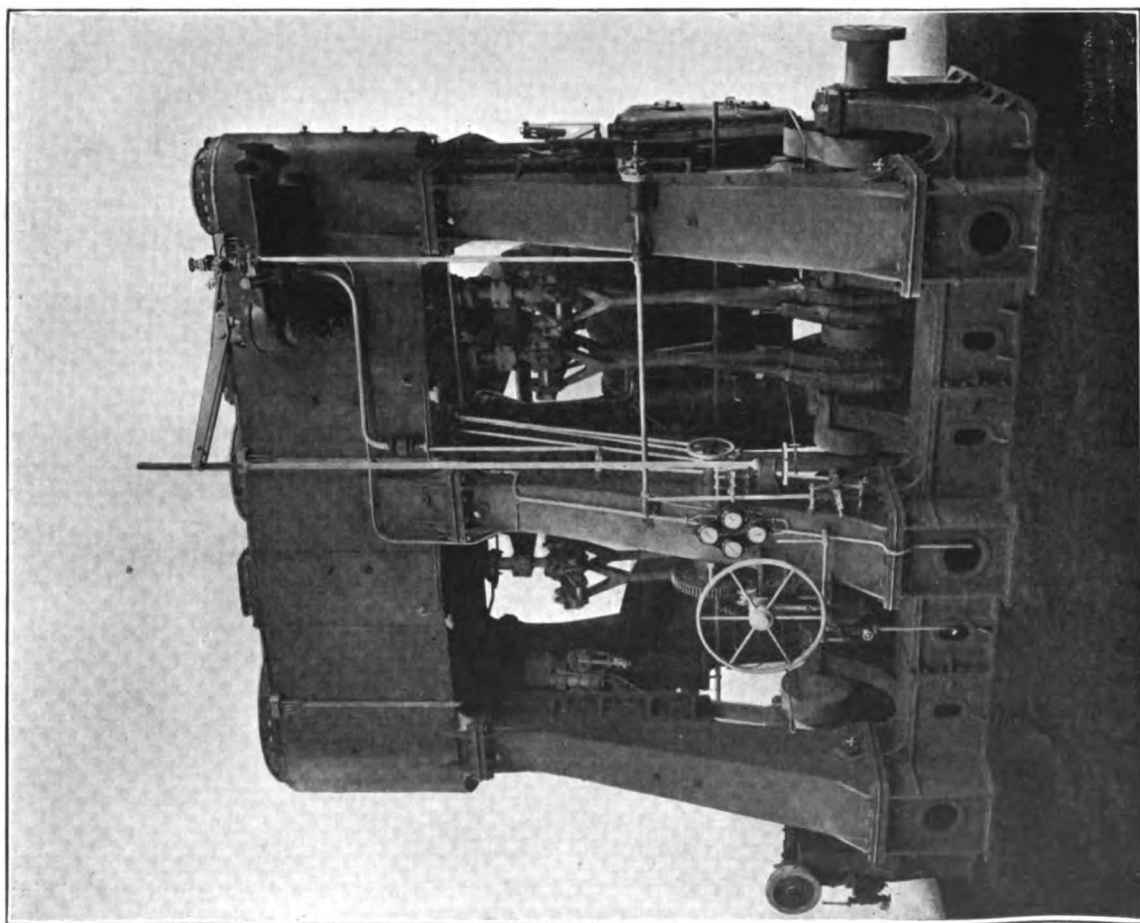


Fig. 1.—Front View

Triple Expansion Engine of 3,250 indicated horsepower, built by Messrs. Richardson, Westgarth & Co., Ltd., of Hartlepool for the steamship *Northwestern Miller*. The cylinder diameters are 29, 49 and 80 inches and the stroke 54 inches

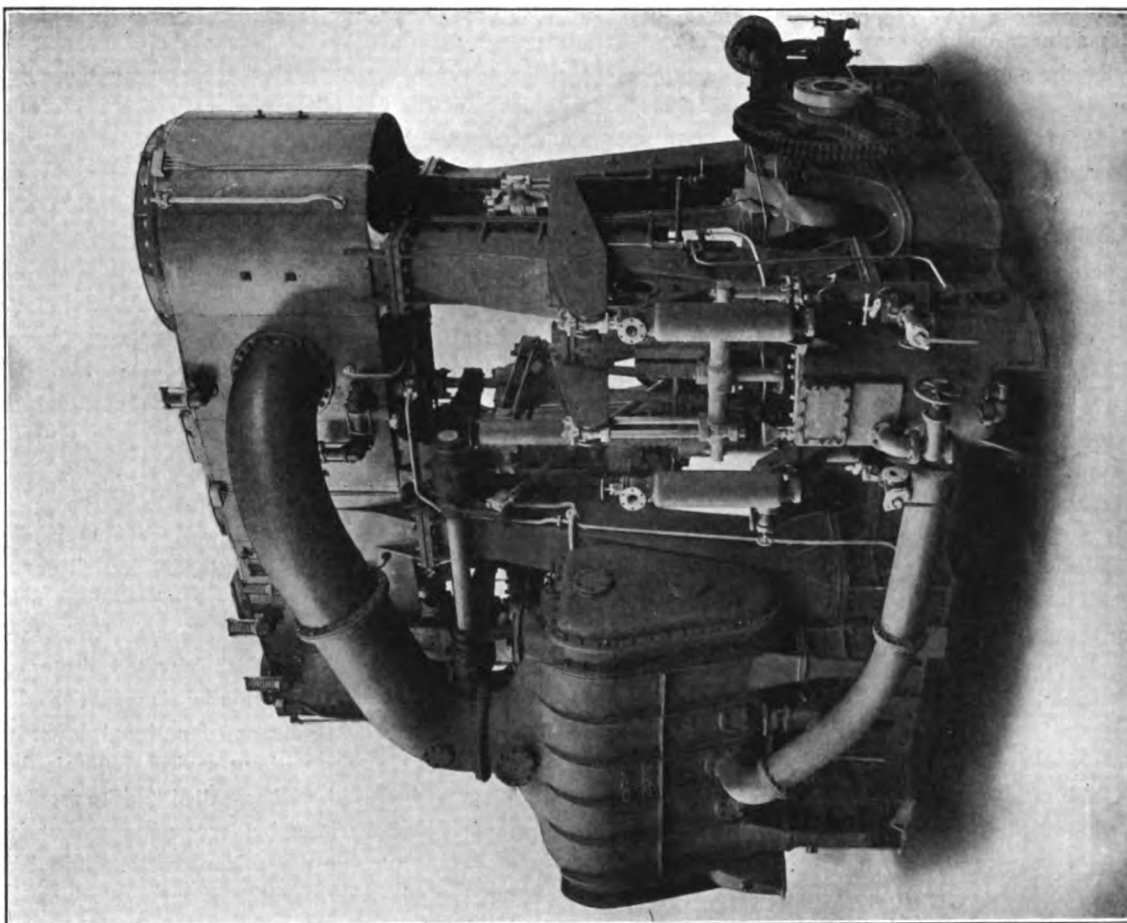


Fig. 2.—Back View

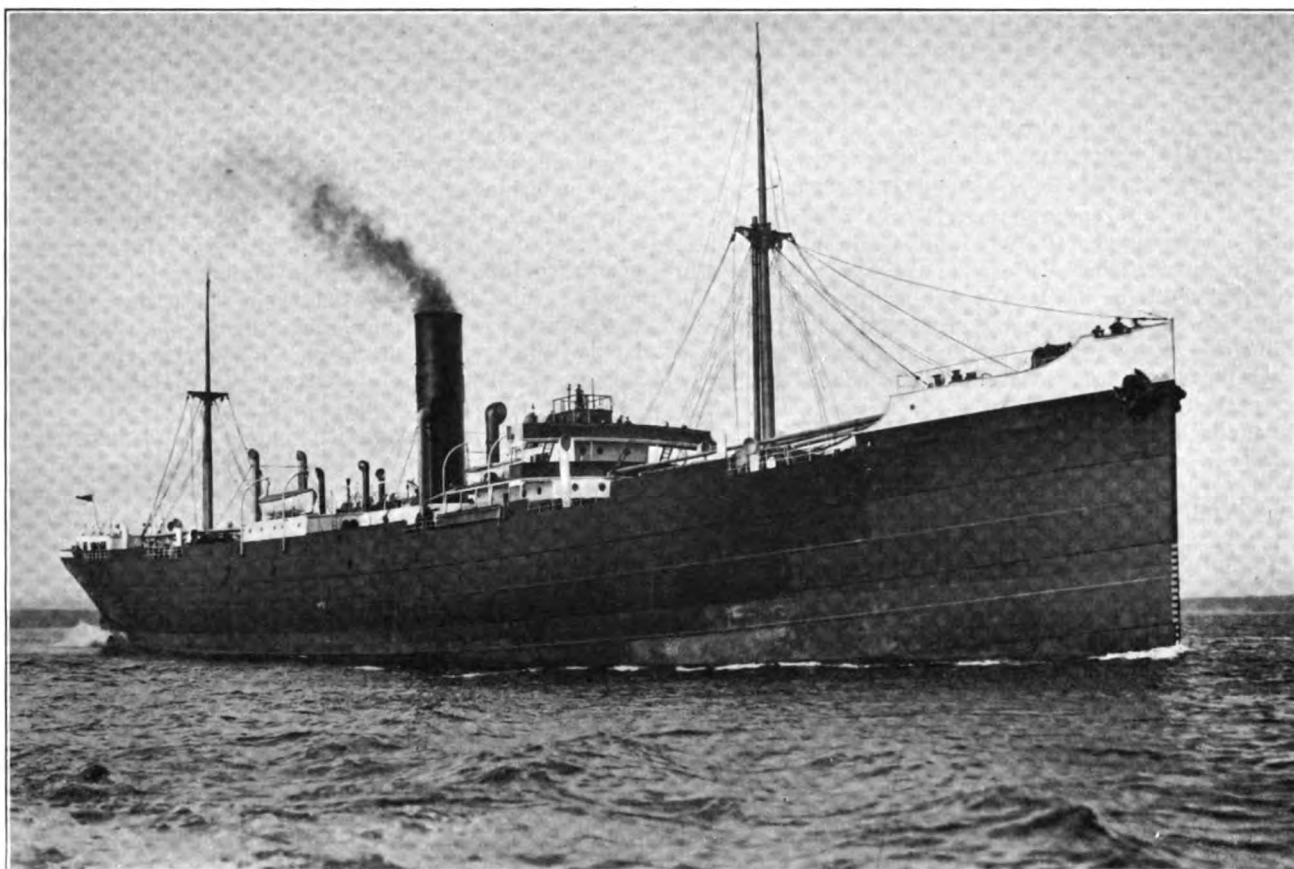


Fig. 3.—Steamship *Northwestern Miller*: Length, 433 Feet 6 Inches; Beam, 53 Feet 6 Inches; Depth, Molded, 39 Feet

New Steamers for American Flour Trade

Built by the Northumberland Shipbuilding Company, Ltd., Howdon-on-Tyne, and Engined by Messrs. Richardsons, Westgarth & Company, Ltd., of Hartlepool, for the Philadelphia Transatlantic Line

BY FREDERICK C. COLEMAN

Two steamers, specially designed for the conveyance of flour, were ordered in England last year from the Northumberland Shipbuilding Company, Ltd., of Howdon-on-Tyne, by Messrs. Furness, Withy & Co., Ltd. These vessels, named the *Northwestern Miller* and *Southwestern Miller*, have recently entered the North Atlantic trade in the service of the Philadelphia Transatlantic Line, between London and Philadelphia. They are of uniform design and dimensions, and each takes the highest class at Lloyds, 100 A1. The following are the principal dimensions:

Length overall	433 feet 6 inches
Length between perpendiculars.....	420 feet
Breadth, extreme	53 feet 6 inches
Depth, molded, to shelter deck.....	39 feet
Shelter 'tween decks.....	8 feet 6 inches
Main 'tween decks	8 feet 6 inches
Draft, laden	26 feet 9 inches
Draft in ballast and bunkers.....	16 feet 6 inches
Deadweight, including bunkers.....	8,600 tons
Coefficient.....	.73

The vessels are built on the three-deck principle, including a shelter deck with deep frames of heavy bulb angle section.

The decks are carried on heavy tandem girders and wide-spaced, built-up pillars, thus keeping the holds and 'tween decks exceptionally clear for the convenient stowage of large and bulky cargoes. An orlop deck extends the full length of No. 1 hold and is suitable for carrying special cargo.

There are seven steel watertight bulkheads and a cellular double bottom extends fore and aft for water ballast, and water ballast is carried in a deep tank built aft of the engine-room bulkhead and in fore- and after-peak tanks, as shown in the table given below.

The vessels are schooner rigged, the fore and main masts being built specially strong to deal with 25-ton lifts. There are four derrick posts to handle cargo in the deep tank and No. 3 hatch, and a total of sixteen derricks, one of which, fitted at the after side of the fore mast, is capable of dealing with 25-ton lifts at No. 2 hatch. There are six cargo hatches, four of which are 26 feet 6 inches by 18 feet, one 13 feet 3 inches by 18 feet, and another 15 feet 5 inches by 18 feet. Grain divisions and shifting boards are supplied in Nos. 2, 3 and 4 holds.

The deck machinery includes eleven 7-inch by 12-inch steam winches, fitted with large barrels and whipping and warping drums, and these were supplied by Messrs. Clarke,

Chapman & Co., Ltd., and there is also a quick-warping steam windlass, which was supplied by Messrs. Emerson, Walker & Co., Ltd. The steam steering gear is of the Wilson-Pirie type, controlled by Brown's telemotor gear, amidships, and there is also hand gear. There is a Kelvin patent standard compass and sounding machine.

The following are tables of the various capacities:

SHELTER 'TWEEN DECKS

	Grain	Bales
Forward shelter 'tween decks.....	64,000	57,600
After shelter 'tween decks.....	57,150	51,500
Casing side	15,550	14,000
Cabin store	3,700	3,500
Forecastle	5,040	4,530
Fore-peak stores	6,900	2,620
Tonnage well	1,480	1,350
After peak	4,330	.....

Total capacity 158,150 135,100

MAIN 'TWEEN DECKS

	Grain	Bales
No. 1 'tween decks.....	20,900	19,000
No. 2 'tween decks.....	39,700	36,200
No. 3 'tween decks.....	15,900	14,500
No. 4 'tween decks.....	20,900	19,000
No. 5 'tween decks.....	18,800	17,100
Total	116,200	105,800

HOLDS

	Grain	Bales
No. 1 hold, upper.....	20,900	27,500
No. 1 hold, lower.....	20,750	19,100
No. 2 hold.....	98,200	91,400
Deep tank	32,700	30,600
No. 3 hold.....	49,100	45,200
No. 4 hold.....	33,500	30,500
Total capacity	264,150	244,300

BUNKERS

	Tons
Engine and boiler room, port side.....	112
Engine and boiler room, starboard side.....	135
Total in engine and boiler space.....	247

'Tween decks (port side)	118
'Tween decks (starboard side)	136
Shelter 'tween decks (port and starboard sides)	320
Coal shoot	20

Total bunker capacity 850

WATER BALLAST

	Tons
No. 1 tank.....	135
No. 2 tank.....	490
Dry tank (74 tons) .....	.....
No. 3 tank.....	155
No. 4 tank.....	350
No. 5 tank.....	100
Deep tank	955
After-peak tank	125
Fore-peak tank	110

Total capacity 2,420

The accommodation throughout is fitted with steam heating, and the ventilation of the lower holds and 'tween

decks was specially considered, four ventilators being fitted to each hold and 'tween decks. The electric lighting installation comprises twelve large cargo clusters, mast head, side and stern lights. The anchors are of Byers' patent stockless type.

A large dining room for the captain and officers is situated amidships on the shelter deck, and the captain, chief officer and Marconi wireless operator are berthed in a large steel deckhouse on the top of the saloon house. The officers, engineers and apprentices are berthed in steel deck houses at the side of the vessel on the shelter deck, abreast of the engine room casings, while the crew are accommodated aft under the shelter deck, and have cubicles for the separate watches. The mess room is fitted in the center alleyway. The petty officers' quarters, hospital, wash house and toilet rooms are on the large steel deck house aft on the shelter deck.

The propelling machinery of each of these vessels, supplied and fitted by Messrs. Richardsons, Westgarth & Co., Ltd., of Hartlepool, consists of a set of powerful triple-expansion engines, specially designed for the heavy North Atlantic trade. The bearing surfaces are exceptionally large, and the scantlings throughout are of very ample proportions. The cylinders are 29 inches, 49 inches and 80 inches diameter by 54-inch stroke. The indicated horsepower is 3,250 and the nominal horsepower 681.

Steam is supplied by three large single-ended boilers, 17 feet 6 inches diameter by 12 feet length, each working at a pressure of 180 pounds per square inch and having four furnaces and arranged for Howden's system of forced draft. The heating surface is 10,450 square feet.

Both main and auxiliary condensers are of the Contraflo type, this system being adopted in its entirety, with compensator exhaust steam surface feed heater and Cascade filter. The propeller shaft is forged of "lockfast" iron, fitted with continuous gun-metal liner, and the propeller is of solid manganese bronze.

The large number of auxiliaries in the engine room include centrifugal circulating pump with enclosed engine, independent, slow-speed feed pumps, extra large ballast pump, auxiliary feed pump, and a Morison's evaporator.

The machinery was built to pass the Board of Trade and Lloyd's requirements, and to the inspection of Messrs. Esplen & Sons, Ltd., of Liverpool. These two vessels have a service speed of about 13 knots.

First Diesel-Engined Vessel for the United States Navy

The U. S. S. *Maumee* is one of two twin-screw fuel ships authorized by the Naval Appropriation Act of August 22, 1912, "to cost, exclusive of armor and armament, not to exceed one million, one hundred and forty thousand dollars (£234,000) each, and which shall be built in navy yards, one to be built in a navy yard on the Pacific Coast." These two vessels, the *Maumee* and her sister ship, the *Kanawha*, were built in the Mare Island Navy Yard to carry fuel and minor supplies for the fleet.

The *Kanawha*, now in commission with a merchant complement, is propelled by two triple-expansion steam engines of 2,600 indicated horsepower each, while the *Maumee* is to have for propelling machinery two Diesel engines of 2,500 brake horsepower each. At the time these vessels were authorized there were already afloat a number of motor ships whose performance warranted the adoption in our service of Diesel motors of the heavy, slow-speed type for our auxiliary vessels. The sum of

money available for the construction of the *Maumee* was based on steam-engine propulsion, and was not sufficient to cover the entire cost of experimental and construction work of a pair of large Diesel engines.

In order to introduce this type of motive power into our service, a Naval Appropriation Act of March 4, 1913, provided "that the unobligated balances under the appropriation 'Steam Machinery' for the fiscal years ending June thirtieth, nineteen hundred and twelve, and June thirtieth, nineteen hundred and thirteen, not exceeding \$250,000 (£51,250) are hereby reappropriated and made available for the development of a type of heavy-oil engine suitable for use in one of the fuel ships authorized by the act approved August twenty-second, nineteen hundred and twelve, and the expenditure thus incurred shall not be a charge against the limit of cost of such vessel."

It is the present intention of the Navy Department to man the *Maumee* with officers of the navy and an enlisted crew.

The two ships are similar except as to their propelling machinery, which, however, will be kept within the same machinery spaces on both vessels; that is, between frames 136 and 166. Externally their appearance will be the same, except that the smokestack of the *Maumee* will come out of the after end of the machinery spaces, while that on the *Kanawha* will come out of the forward part of the machinery spaces. The *Kanawha* has four Babcock & Wilcox boilers forward of the main engines, while the *Maumee* will have two boilers of the same make, but smaller in size, just abaft the main engines.

These two vessels will afford an excellent opportunity of comparing the two types of machinery, as they are not only sister ships, but they will be employed on identically the same duty, and will probably burn the same grade of fuel. It would be premature at this writing to attempt any comparison between the two vessels, except that the *Maumee's* propelling plant will be more costly and considerably heavier than that of the *Kanawha*. A comparison of weights, however, should also include the fuel to cruise considerable distances, in which latter case the question of weight will be in favor of the *Maumee's* plant, owing to the unquestioned higher fuel economy of the Diesel motor over that of the steam engine.

The principal characteristics of these two vessels are given as follows:

Length between perpendiculars.....	455 feet
Beam	56 feet
Draft (loaded)	26 feet 4 inches
Tonnage (loaded), about.....	15,000 tons
Speed (loaded)	14.5 knots
Cargo capacity, fuel oil.....	10,000 tons

The main propelling machinery of the *Maumee* is being built at the navy yard, New York, and consists of two single-acting, two-cycle, six-cylinder, Diesel engines of the slow-speed, cross-head, heavy-duty type. Each engine will develop its full power of 2,500 brake horsepower at 130 revolutions per minute.

In order to gain a maximum of Diesel-engine experience in a minimum of time, the Bureau of Steam Engineering decided to obtain the manufacturing rights and a set of working plans from some company already engaged in that line of work, and to build the engines in one of the navy yards. The Navy Department, therefore, obtained bids from various shipbuilding and manufacturing companies, both at home and abroad, and finally contracted with the Electric Boat Company, of Groton, Conn., American licensees of the Maschinenfabrik-Augsburg-Nurnberg, or M. A. N. Company, of Nuremberg, Germany.

The Electric Boat Company, through a subsidiary company, the New London Ship and Engine Company, manufactures two-cycle, single-acting Diesel engines of the M. A. N. type for submarines and other marine work. This company also manufactures a four-cycle Diesel engine for marine use, but up to date has not constructed engines of the heavy-duty, slow-speed type used in ocean-going vessels.

The contractor obtained the original design and drawings from the home company, translated all figures from the metric to the English system, and supplied the Government with a set of retraced plans, whereon only slight departures from the original design were made. The navy yard, New York, checked the translated drawings by comparison with the original German drawings, and, after approval by the Bureau of Steam Engineering, built the engines, following the drawings as closely as conditions would permit. It will not be out of place here to observe that it would probably have been cheaper to build the engines using the original metric figures and scales. All the translated figures contained decimals to the thousandth part of an inch, which made the checking extremely tedious, and the work in the shop, where English scales were used, slower than it would have been otherwise. The decimals made it difficult for the man at the machine tool to distinguish between important and unimportant dimensions, so that the result showed considerable time spent in making all dimensions correct.

All parts of the engine were made in the navy yard, except the very few steel castings required, and the heavy connecting rod, piston rod and thrust and line shaft forgings. These forgings were purchased rough turned and finished in the yard. The crankshaft was purchased from the Erie Forge Company, of Erie, Pa.

Each main engine, turning outboard going ahead, drives the following attached auxiliaries:

Three high-pressure air compressors for fuel injection and for charging air starting bottles.

Three scavenger compressors for cylinder scavenging.

Two salt-water pumps for cooling all water-jacketed parts of engine except pistons.

One fresh-water pump for piston cooling.

One lubricating oil pump for thrust block, main, crank-pin, and crosshead bearing lubrication.

Two general service water pumps for fire, bilge or sanitary purposes.

Twelve mechanical lubricators for cylinders and for minor bearing lubrication.

One fuel oil supply pump for pumping fuel from ship's bunker tank to engine supply tanks.

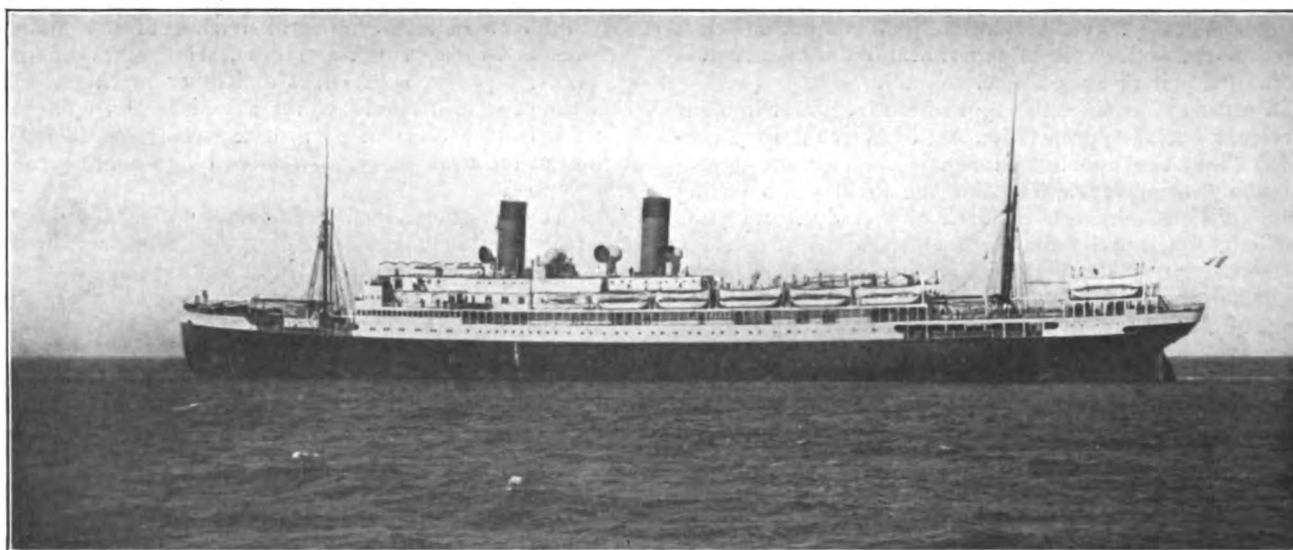
Six fuel oil measuring pumps for supplying fuel to cylinders from engine-room tanks.

One speed governor, one tachometer and one revolution counter.

The diameter of the cylinders in each engine is 25.197 inches. The length overall of each engine is 52 feet 4.63 inches, and the height from the centerline of the crankshaft to the centerline of the cam shaft at the cylinder heads is 18 feet 9.197 inches.

One of the pair of engines is practically complete and has been given exhaustive trials on the test bed in shops at the navy yard in Brooklyn. It will be several months, however, before the engines have been installed in the *Maumee*, and service trials can be carried out at sea for comparison with the performance of her sister ship propelled by steam power.

At the shop tests the engine was operated on an oil similar to the standard grade of fuel oil used in the steam boilers on vessels of the United States Navy.



New French Liner *Lafayette* for New York Service

New Quadruple Screw Steamship Lafayette

French Line's Service to New York Augmented by Addition of Swift Modern Vessel of 12,000 Tons and 14,400 Horsepower

Recently the Compagnie Général Transatlantique has found it necessary to increase its transportation facilities between French ports and New York by the addition to its present transatlantic fleet of the new quadruple screw steamship *Lafayette*, of 12,000 gross tons and 14,400 horsepower, illustrated on this page.

The *Lafayette*, which is a sister ship of the *Espagne*, is built of steel to the highest requirements of French naval construction, with double hull and numerous watertight compartments. Propulsion is by combination reciprocating and turbine engines actuating four screws. In accordance with the latest requirements the most modern equipment and appliances for safety of life at sea have been provided. Life rafts have been discarded and a complete equipment of thirty-eight Lundin lifeboats has been installed with Welin launching davits.

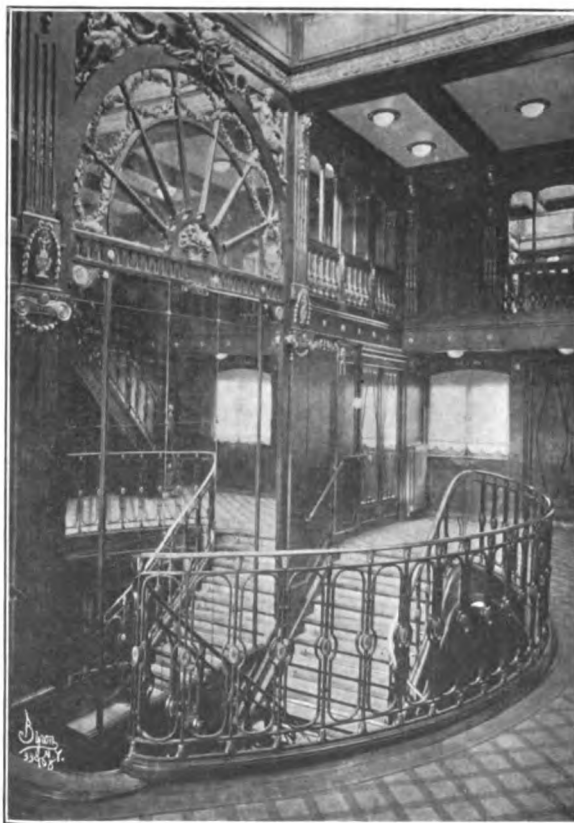
French Line ships have long been noted for the character and quality of their interior fittings and for the comfort, convenience and luxury provided for their passengers. In these respects the *Lafayette* fully maintains the reputation established by her predecessors. The public rooms are of ample size, exquisite in appointments and luxuriously furnished.

Both first and second class accommodations are provided. The suites de luxe and the cabines de luxe are situated on the boat and promenade decks, thus having plenty of outside light and natural ventilation. The promenade deck is long and spacious and the forward portion is sheltered by thick plate glass panels.

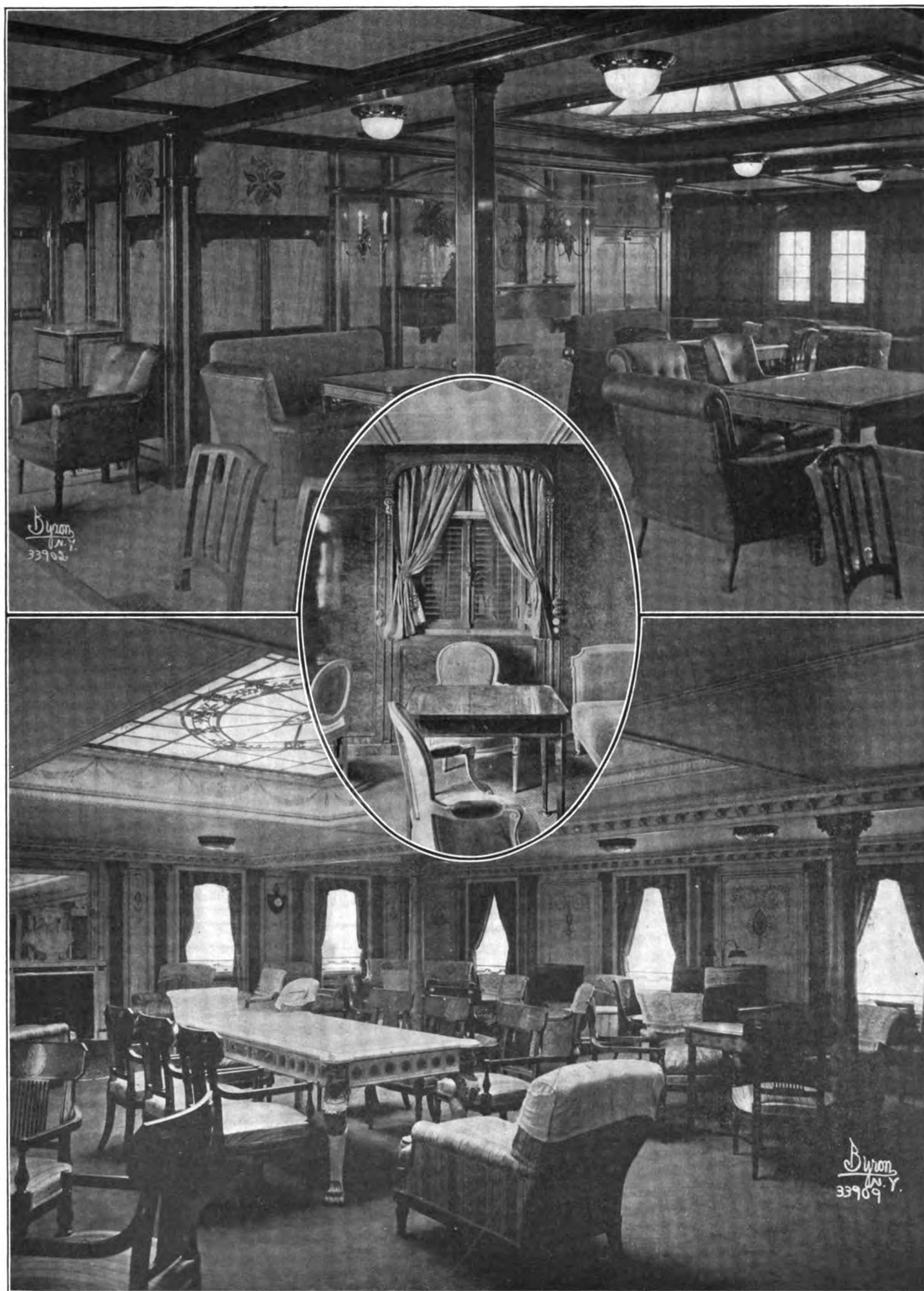
Special provision has been made for the care of children on the ship, including a play-room of generous size and also a Punch-and-Judy theater, which is a novelty on board ship.

In addition to the special suites, all of which are provided with bath and toilet, other first class cabins are provided on the upper deck, each furnished with a lower berth and sofa. All of these cabins are supplied with hot and cold running water, with direct outlet to the sea. In addition to natural ventilation for the cabins, electric fans draw in fresh air from the outside and force this into ducts leading to all the staterooms. This fresh air supply can be controlled within each stateroom independently of the other rooms. The reading, writing, social and smoking rooms are all of large size.

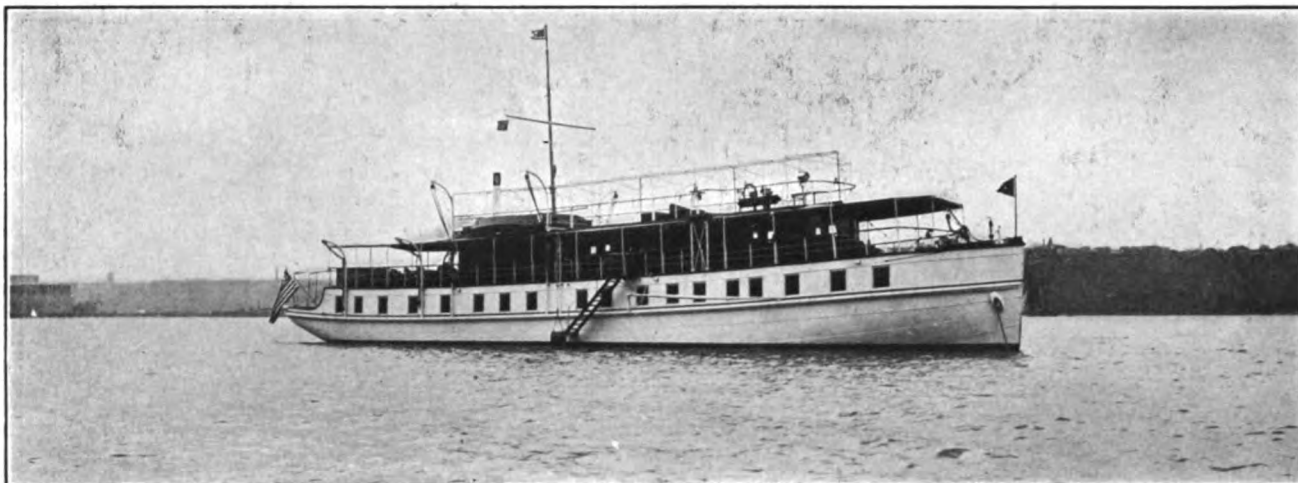
The *Lafayette's* maiden voyage to New York was successfully completed in November.



Main Stairway



Upper View—First Class Smoking Room. Lower View—First Class Drawing Room. Inset—Cabin de Luxe



(Photograph copyright by Edwin Levick, New York)

Fig. 1.—Houseboat *Captiva*. Designed by Gielow & Orr for Mr. Harry Payne Whitney

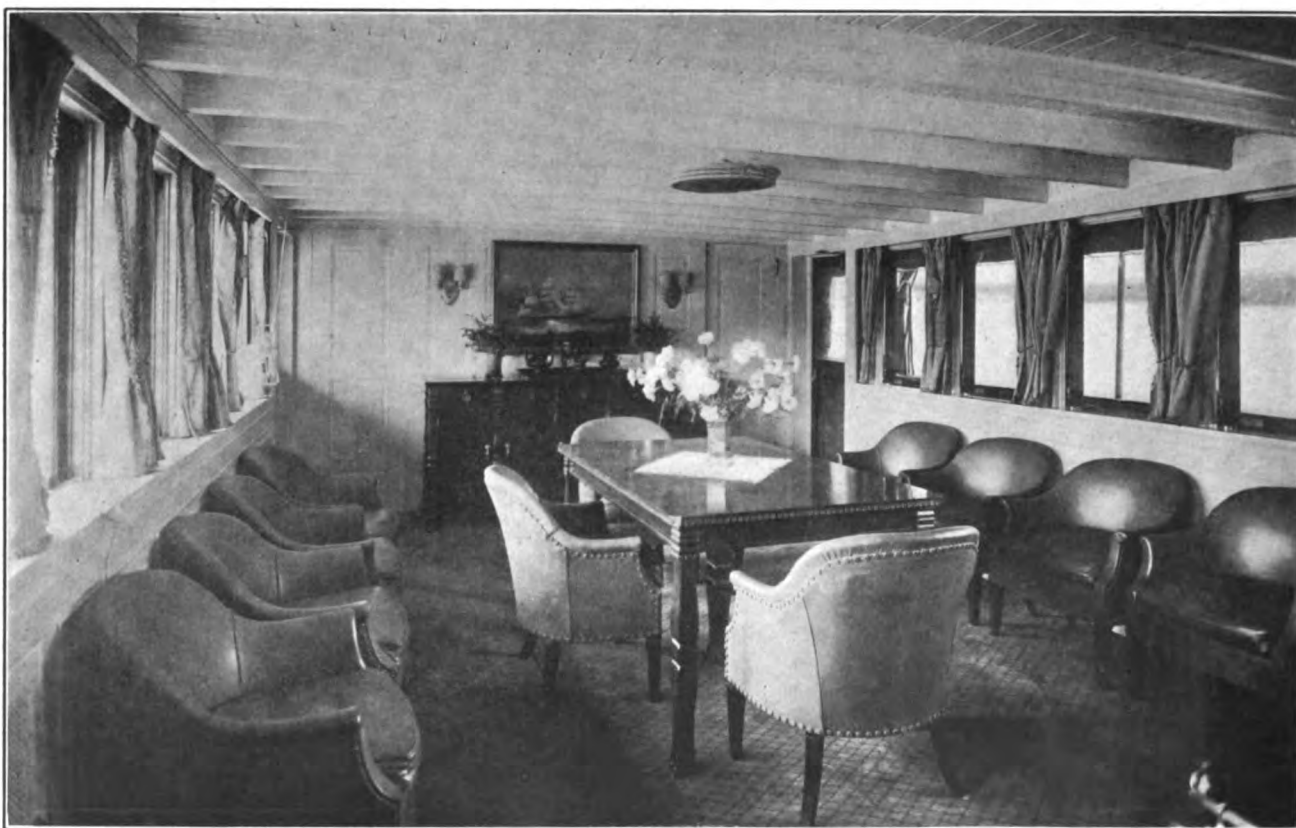
Shallow-Draft Houseboats for Yachtsmen

Large Power Boats Recently Designed by Gielow & Orr, of York, for Navigating Inland Waters

The characteristics of the Atlantic coast of the United States, as well as of the inland bays and navigable streams, furnish a wide diversity of cruising grounds for pleasure power boats. For a vessel of this type to be serviceable in the inlet and bays of the New England coast and down to the sunny lagoons, shallow streams and inland bays of Florida, a craft is required which combines the seagoing qualities of a good motor yacht with the more material

comforts of a roomy houseboat. Light draft is essential for winter cruising in southern waters, and a fair amount of speed and seagoing qualities are also required to enable the owner of such a boat to make the long run between the winter and summer cruising grounds.

Many craft of this type have been designed by Messrs. Gielow & Orr, of New York City, during the past fifteen years, two of the latest of which are illustrated herewith.



(Photograph copyright by Edwin Levick, New York)

Fig. 2.—Dining Saloon of the *Captiva*

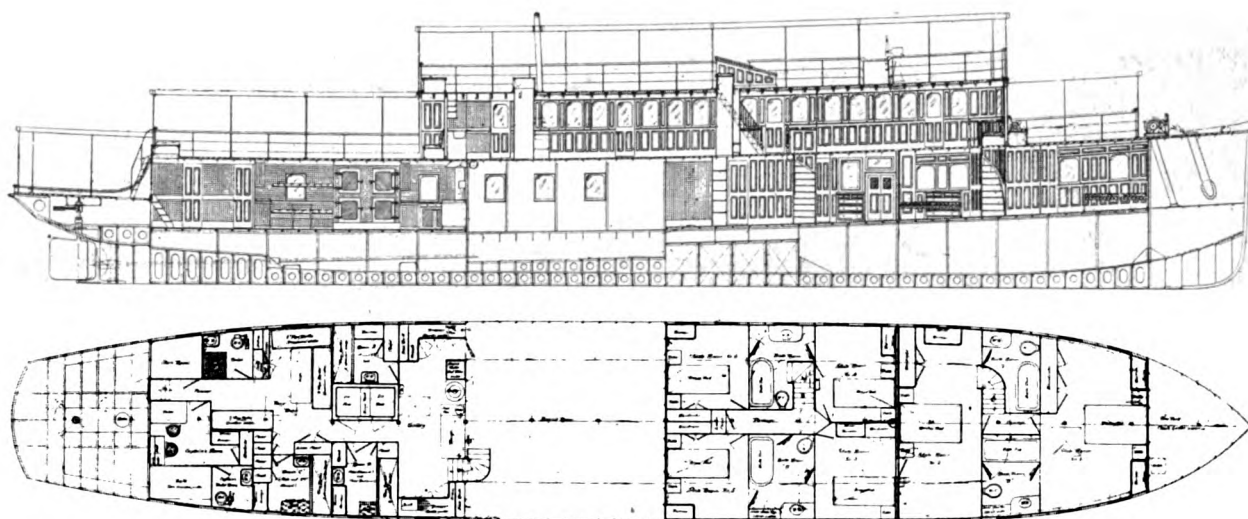
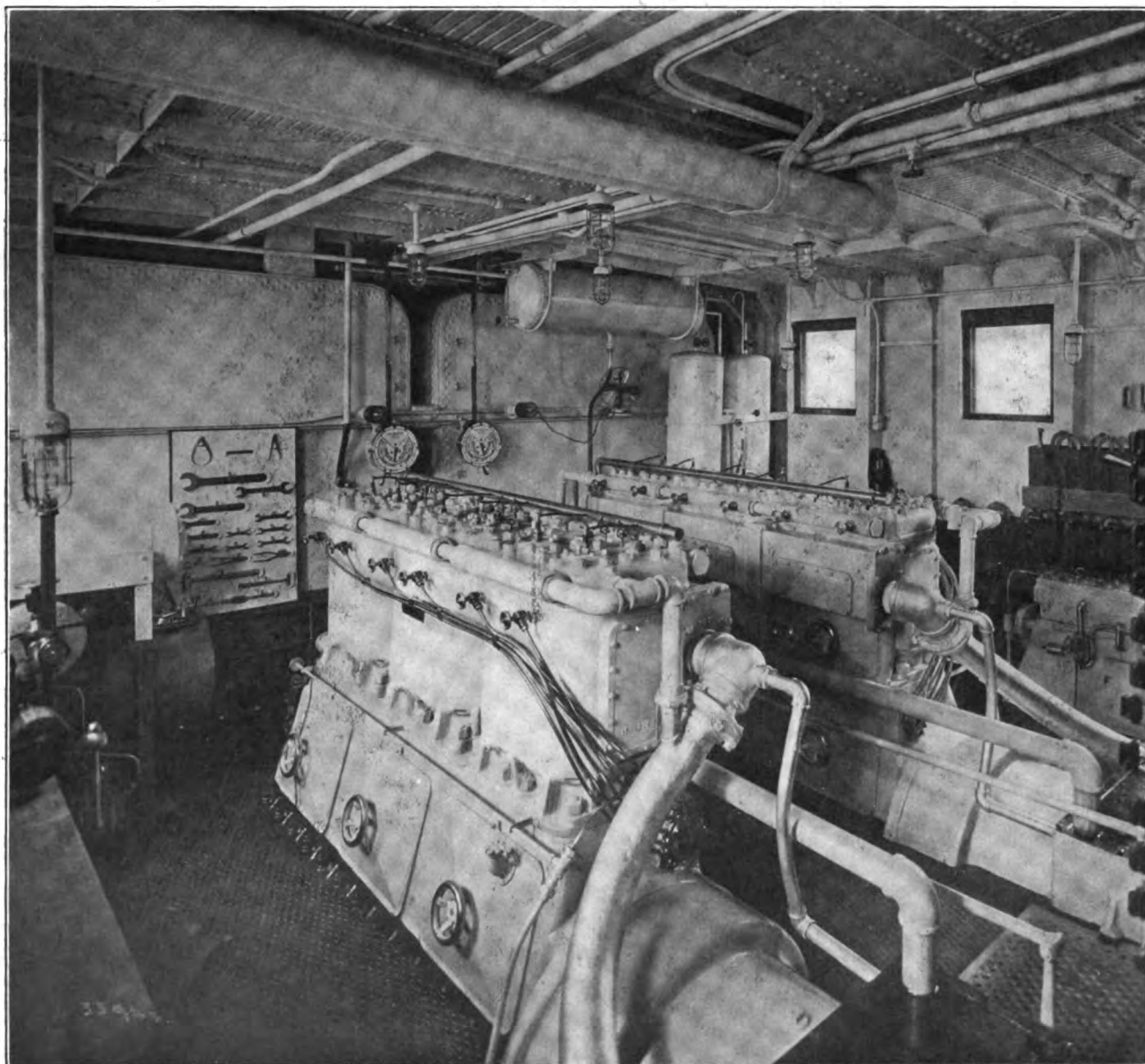


Fig. 3.—Profile and Deck Plan of the *Captiva*



(Photograph copyright by Edwin Levick, New York)

Fig. 4.—Engine Room of the *Captiva*, Showing Two 200-Horsepower, Six-Cylinder, Winton Motors

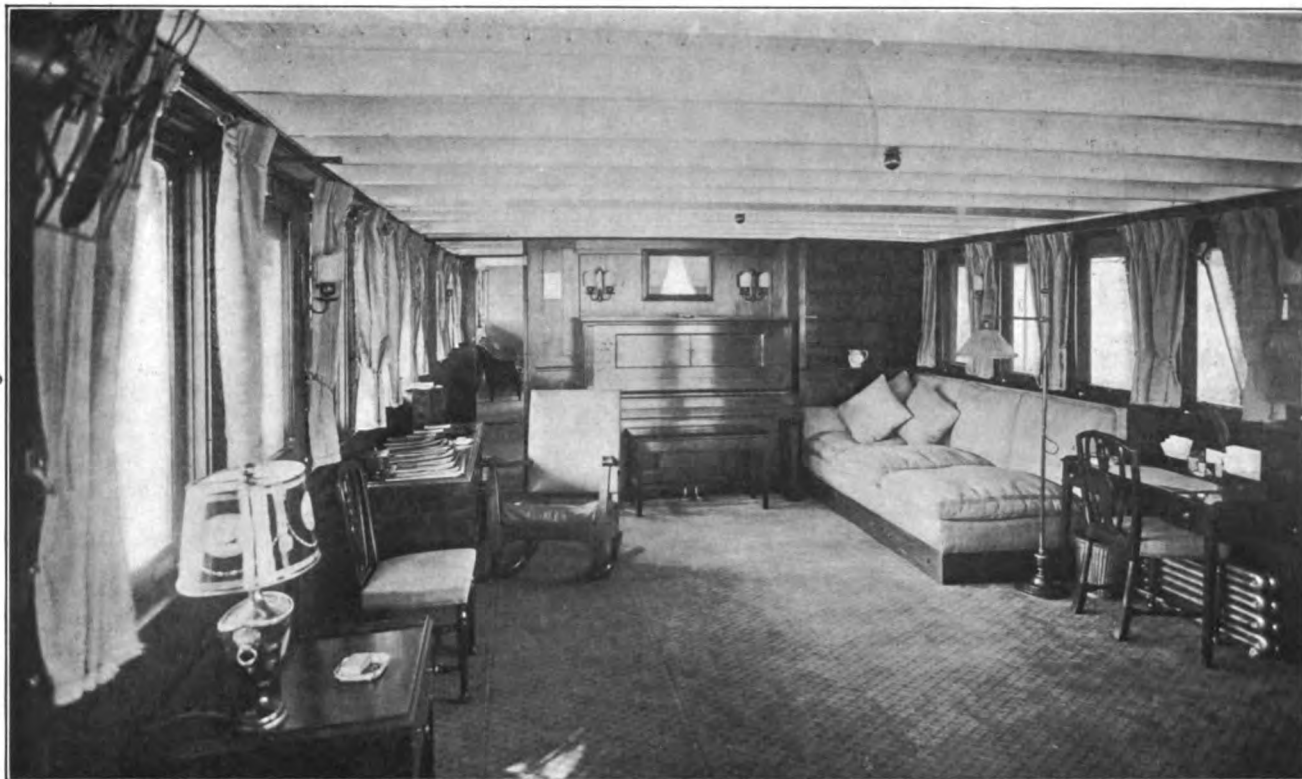
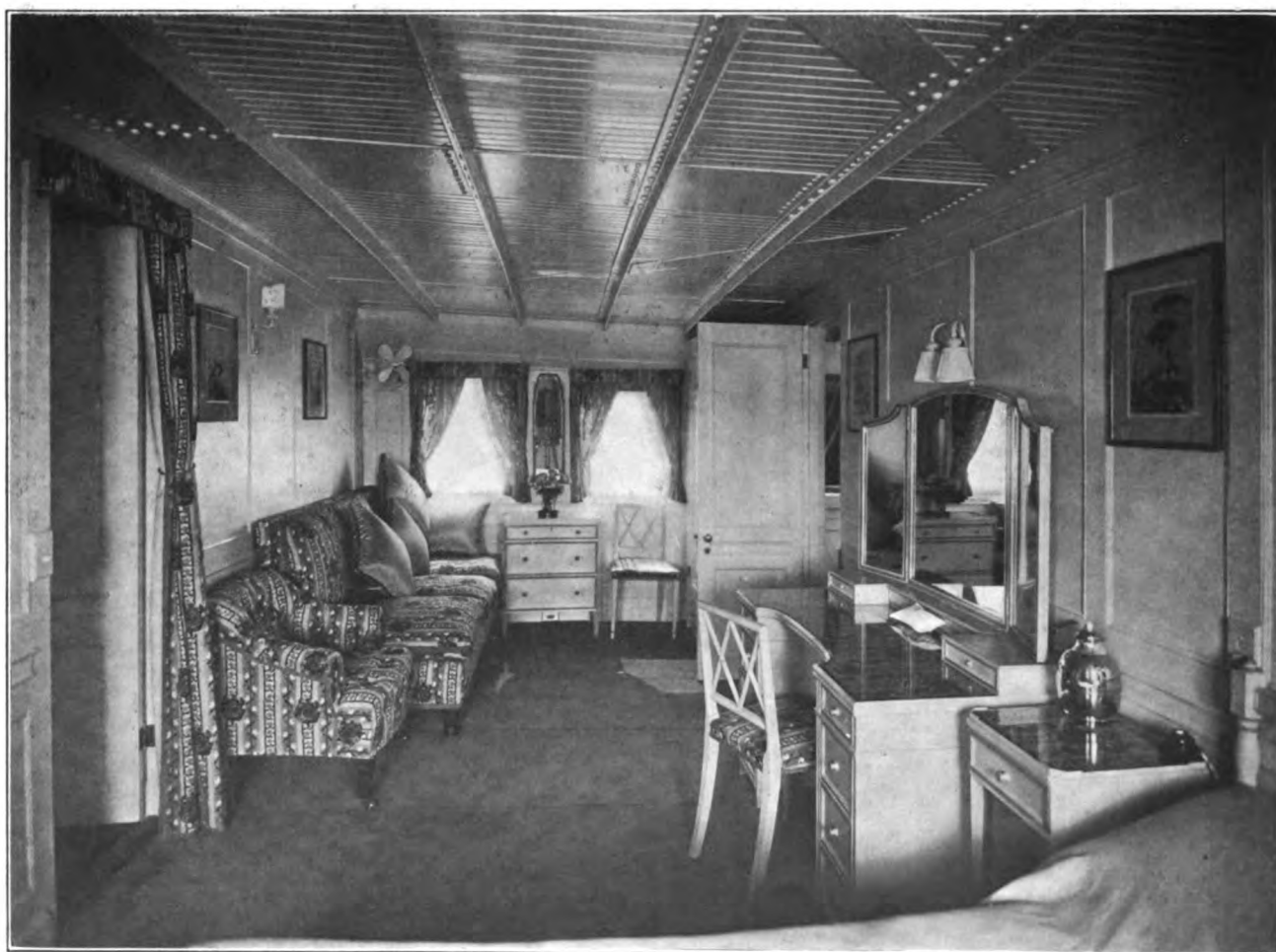


Fig. 5.—Main Living Room



(Photographs copyright by Edwin Levick, New York)

Fig. 6.—Stateroom

The first is the *Captiva*, built by J. W. Sullivan, New York, last May for Mr. H. P. Whitney, of the New York Yacht Club. The boat is of steel, 130 feet 6 inches long overall, 121 feet long on the waterline, 21 feet beam and 4 feet draft, fully loaded. The hull is divided into six watertight compartments by five transverse bulkheads. The keel is of the flat plate type, 48 inches wide, of No. 2 B. W. G., with the vertical keelson of No. 4 B. W. G. 18 inches amidships increased at the ends. The frames are 2½-inch by 2½-inch by 4.1-pound angles, and the reverse frames 2-inch by 2-inch by 3.2-pound angles. The floors are of steel plate, No. 4 B. W. G., and the deck beams of 3-inch

Manitowoc, Wis., for Honorable James D. Cameron, from designs by Messrs. Gielow & Orr, of New York. This is the *Conewago*, which is constructed of wood throughout, 100 feet long overall, 90 feet 9 inches length on waterline, 18 feet beam under guards, with a full load draft of 3 feet. The boat has a deckhouse of mahogany arranged with an observation and smoking room forward and a dining room and pantry aft. Below decks are the owner's stateroom, six guests' rooms, a large galley, the engine room, and finally, in the stern, accommodations for the officers and crew.

The propelling machinery consists of two Winton gaso-

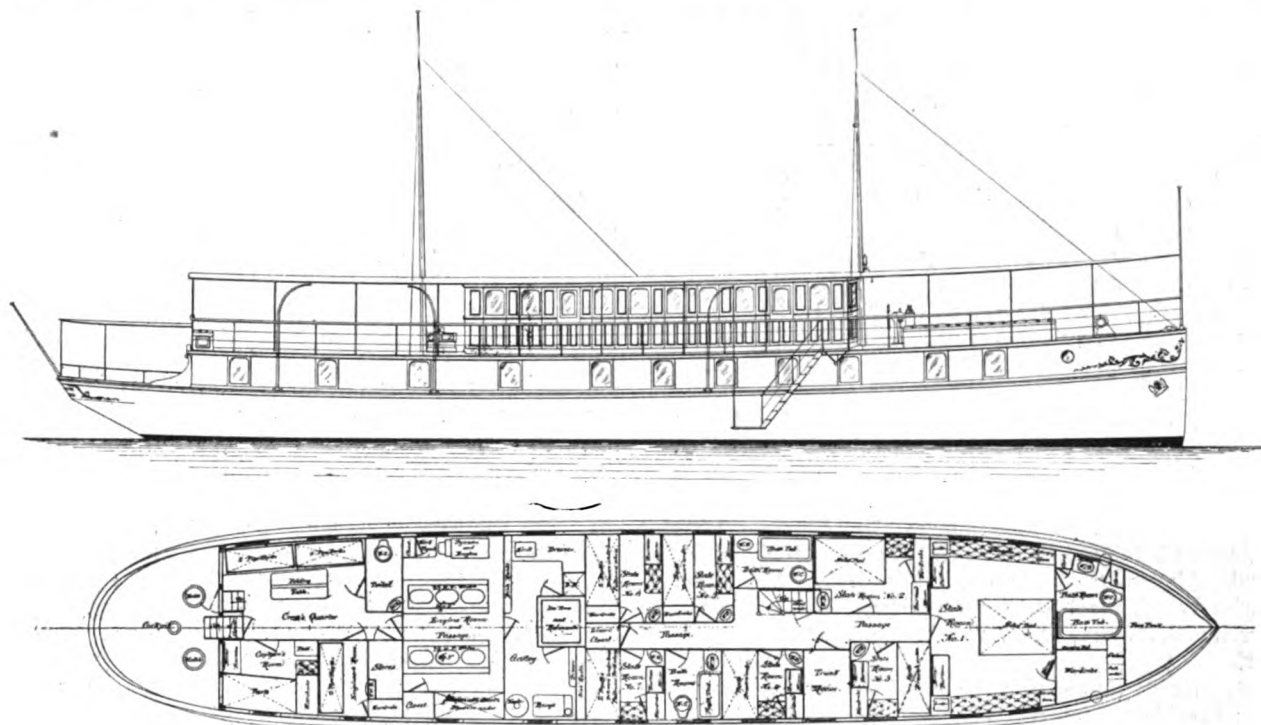


Fig. 7.—General Plans of Houseboat *Conewago*

by 2-inch by 4.1-pound angles. The plating is of steel, ranging from No. 2 to No. 5 B. W. G., worked in in-and-out strakes, and extending up to the upper deck.

The deckhouse of mahogany is 62 feet long, with a mean width of 13 feet 6 inches. In the forward end is the main saloon or social hall. Immediately aft is the lobby and chart room, while next comes the dining room and pantry. The owner's and guests' quarters are in the forward part of the vessel and occupy the entire width for a fore-and-aft distance of 50 feet 6 inches. Amidships is the machinery space and aft of that the galley and officers' and crew's quarters.

The propelling machinery consists of two 200-horsepower, six-cylinder Winton gasoline (petrol) motors, manufactured by the Winton Gas Engine & Manufacturing Company, of Cleveland, Ohio, with cylinders 9 inches diameter by 14 inches stroke, driving 46-inch propellers designed to give the vessel a speed of 14 miles per hour. The engines are entirely enclosed with two separate sets of magnetos and two spark plugs in each cylinder. The gasoline (petrol) tanks have a capacity of 6,000 gallons. Among the auxiliaries are two 5-kilowatt Winton electric lighting sets, supplying current for a searchlight, electric pumps, compressors, storage batteries, etc. There is also a refrigerating and ice-making plant and steam heating plant.

Another boat of similar type was recently built at

line (petrol) engines, manufactured by the Winton Gas Engine & Manufacturing Company, of Cleveland, Ohio. These engines each have six cylinders, 6½ inches diameter by 9 inches stroke, which are capable of driving the boat at a maximum speed of 11 knots and a normal cruising speed of 10 knots. The fuel tanks have a capacity sufficient to give a cruising radius of 1,200 miles.

The *Conewago's* first run from the builders' yard at Manitowoc, Wis., to New York City by way of the Great Lakes, down the St. Lawrence River and then down the Atlantic coast, covered a distance of 3,186 miles. The trip was made in 13 days and 7 hours' actual running time, the fuel consumption for the entire trip being 2,540 gallons of gasoline (petrol) or .8 gallon per mile.

NEW ITALIAN TRANSATLANTIC LINER.—The new twin-screw steamer *Giuseppe Verdi* of the Transatlantica Italiana Line, built especially for the service between New York, Genoa, Naples and Palermo, reached New York on November 19 on her maiden voyage. She is 505 feet 3 inches long over all, 480 feet long between perpendiculars, 59 feet 8 inches beam and 37 feet depth. Her gross tonnage is 9,773 and she was designed for a service speed of 18 knots. Accommodations are provided for 96 first class, 135 second class, 100 intermediate and 1,792 steerage passengers.

Naval Architects' Annual Meeting

Twenty-third Convention of the Society of Naval Architects and Marine Engineers—Abstracts of Principal Papers Read

The twenty-third annual meeting of the Society of Naval Architects and Marine Engineers was held at the Engineering Societies Building, New York, on November 18 and 19. Colonel Robert M. Thompson, president of the society, presided at the professional sessions, which were held both morning and afternoon of each day of the convention, and also acted as toastmaster at the annual banquet which was held on the evening of the nineteenth at the Waldorf Astoria hotel, where the all-important question of military preparedness was discussed from many points of view.

The annual report of the secretary-treasurer showed that the membership of the society at the close of the annual meeting in 1914 was 813. During the past year the society lost fifteen members by death, while seven resigned. During the meeting, however, thirty-six new members were elected. From November 1, 1914, to October 31, 1915, the total receipts were \$11,329.75 (£2,320) and the total disbursements \$10,138.67 (£2,080). The total resources of the society are \$29,408.22 (£6,025) and its total liabilities \$595 (£122), making the society's present worth (on October 31, 1915) \$28,813.22 (£5,903), divided as follows: Working capital, \$15,368.22 (£3,150); endowment fund, \$12,560 (£2,575), and income earned, \$885 (£178).

The following deaths were recorded during the year: G. A. Bisset, A. J. DuBois, Charles A. Harrington, Henry S. Hayward, John B. Hereshoff, Albert L. Hopkins, John Lloyd, Alexander J. Maclean, Frederick G. Rogers, Charles Ward, Jacob R. Andrews, Ransford D. Bucknam, Harrison B. Moore, D. S. Vassilieff and Revere B. Pulsifer.

The officers elected for the coming year were as follows: President, Stevenson Taylor; vice-presidents (term expiring December 31, 1918), H. I. Cone, Lewis Nixon, G. W. Dickie, G. E. Weed; members of council (term expiring December 31, 1918), H. A. Magoun, W. J. Baxter, Andrew Fletcher, R. H. Robinson, W. D. Forbes, W. G. Coxe; associate members of council (term expiring December 31, 1918), J. S. Hyde, H. D. Goulder. D. H. Cox was re-elected secretary-treasurer.

The following were elected to membership in the society:

Life Associate Member.—Colonel Robert M. Thompson, New York.

Members.—Cornelius A. Binks, superintending engineer, New York & Cuba Mail Steamship Company, New York; Frederick H. Chase, naval architect, Tams, LeMoine & Crane, New York; Andrew W. Christian, assistant to the president, Harlan & Hollingsworth Corporation, Philadelphia; Neils Christiansen, superintendent of machinery, Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; Albert C. A. Holzapfels, vice-president, Holzapfels, Ltd., New York; Russel C. Jones, manager, marine department, Griscom-Russell Company, New York; George F. Lawley, president, George F. Lawley & Son Corporation, Neponset, Mass.; Johan H. Lindroos, draftsman, Cox & Stevens, New York; John S. Leitch, general manager, Collingwood Shipbuilding Company, Collingwood, Ont.; David Millar, surveyor, Lloyd's Register of Shipping, Baltimore, Md.; Joseph F. Moran, vice-president, Atlantic Basin Iron Works, Brooklyn, N. Y.; Kurt A. W. Orbanowski, naval architect, New York; Evangelos D. Papayannis, naval constructor, Royal

Hellenic Navy; William W. Smith, engineer, Westinghouse Machine Company, East Pittsburg, Pa.; John F. Wentworth, draftsman, Navy Yard, Boston, Mass.; Cecil W. Weaver, marine estimator, Pusey & Jones, Wilmington, Del.; Ludwig Anderssen, ship and engine surveyor, New York; Henry Holmes, assistant engineer, Esplen & Sons, New York; James McNaught, manager, Esplen & Sons, New York; Frederick J. Smith, superintendent, machine shop, Robins Dry Dock & Repair Company, Brooklyn, N. Y.; Louis N. Lacombe, assistant superintendent, Robins Dry Dock & Repair Company, Brooklyn, N. Y.; Samuel Bennett, surveyor, American Bureau of Shipping, Newport News, Va.

Associates.—Norman R. Dutton, designer, marine machinery, Pusey & Jones Company, Wilmington, Del.; Charles F. de Ganahl, president, Tampico Navigation Company, New York; James A. Guthrie, Jr., marine adjuster, insurance department, Pennsylvania Railroad Company; Von-Fong Lam, student, Massachusetts Institute of Technology, Boston, Mass.; John A. McGregor, president, Union Iron Works, San Francisco, Cal.; Charles H. Macdonald, Art Metal Construction Company, New York; Leigh R. Sanford, United States Engineer Office, Rock Island, Ill.; Henry E. Rossell, assistant naval constructor, U. S. N., Navy Yard, New York.

Juniors.—Henry C. Adams, Jr., shipfitter, New York Shipbuilding Company, Camden, N. J.; Clay L. Jennison, draftsman, United States Coast Guard, Washington, D. C.; Carl E. Petersen, draftsman, Morse Dry Dock & Repair Company, Brooklyn, N. Y.; Philip H. Thearle, draftsman, San Diego Marine Construction Company, San Diego, Cal.; George Laing, Jr., surveyor, the Vessel Agency, New York; Linn M. Rakestraw, student, University of Michigan, Ann Arbor, Mich.

The following are abstracts of the papers read and discussed at the meeting:

Aerodynamical Experiments Upon a Yacht's Mainsail

BY PROFESSOR H. A. EVERETT

ABSTRACT

Experiments were carried out in the aerodynamical laboratory of the Massachusetts Institute of Technology in January, 1915, to determine the possibility of obtaining reliable information concerning the action of sails in the wind. The work resulted in the determination of the location of the true center of pressure, the normal pressure per unit of area for a given wind velocity, and the proper angle of boom to center line for fastest sailing on a given course.

The experiments were carried out with a single sail (a mainsail), as the adoption of two (jib and mainsail) would have injected an indeterminate feature, the inter-relationship between them due to variations in sheet trimming. The sail used was an exact reproduction of a successful sail as used on one of last season's, Class P, racing yachts, and was made accurately to the scale of $\frac{3}{8}$ inch to 1 foot of light, firm China silk. It was made out of a single piece of silk, no attempt being made to reproduce seams, but the roach at the leach of the sail was the maximum which the rule permits and was held out by miniature battens. The sail was carefully cut and made by Wilson & Silsbee in exact conformity with their cutting plan for the full-sized sail.

In carrying out the tests it was considered undesirable to have any sort of body under the sail to which the main sheet could be made fast, as this would inject a disturbing factor into the action of the wind on the sail by disturbing the air flow to the sail, therefore the boom (of 3/16-inch steel tubing) was rigidly attached to the mast (of 5/16-inch steel tubing) at an angle which represented the normal setting of the sail. The gaff was free to swing off and take up whatever position the wind drove it into. The sail was set by throat and peak halyards as nearly as possible in exact conformity with the setting of the actual sail. The sail was provided with battens correct to scale, the attachment to the boom and gaff was by the customary lace lines, and the luff was held to the mast by small brass rings. The sail was vertical at all times, no attempt being made to simulate heel.

The experiments were made possible by the facilities of the aerodynamical laboratory or "wind tunnel" recently established at the Institute in connection with the Department of Naval Architecture under Prof. C. H. Peabody. Their successful conclusion was largely dependent on the hearty co-operation of Assistant Naval Constructor J. C. Hunsaker, who is in direct charge of the aeronautical instruction and this laboratory. The "wind tunnel" consists of a square duct 4 feet on a side through which a current of air is drawn at uniform velocity with a balance under it which supports the models to be tested and weighs the different forces acting on them.

The method of carrying out the observations was to set the sail with the plane of the boom and mast parallel to the center line of the wind tunnel, then by turning the boom up stream to known angles with the center line to measure torque and the moment of the thrust in the direction of the wind and at right angles to it. A plane passed through the boom and mast was considered the plane of reference for all settings. The twisting moment or torque about the mast was measured by the torsional distortion of a calibrated wire in the extension of the axis of the mast. The balance which was used for this work is a copy of the one in use in the National Physical Laboratory in Great Britain, and was built under their direction by the Cambridge Scientific Instrument Company especially for the Institute. It is a remarkable combination of ingenuity and extraordinary instrument-making skill, and has been used extensively for the regular aerodynamical experiments carried out in the laboratory. The observations for thrust and torque were taken for each angle with the speed of the wind maintained constant at 15.1 miles per hour. When the observations of thrust had been completed for all angles the settings were repeated at the same wind velocity for measurements of torque or moment about the mast, as both thrust and moment cannot be measured simultaneously on the balance.

In order to determine the effect of varying wind intensity some of the runs were repeated for winds of approximately 10 miles and 20 miles per hour. It was thought that intermediate points could be filled in by cross fairing from the similar curves derived for 15 miles per hour.

Observations were taken of the moment of the component of the wind pressure on the sail acting along the wind and of the moment of the component acting across the wind and of the moments of the resultant or total pressure about the mast. This gave four equations which, however, contained five unknowns. By repeating the first two observations, with the length of the vertical arm shortened 6 inches, two more equations were added without increasing the number of unknowns, which resulted in six equations involving five unknowns. The unknowns were: First, the transverse component of the wind pressure; second, the down-stream component; third, fourth

and fifth, the co-ordinates of the center of pressure, measured respectively along the wind, across the wind, and vertically, origin at the intersection of the bottom of the boom with the center line of the mast. The known quantities were the weights on the scale beams, the torque and the length of the weighing arms.

The solution of the equations gave the horizontal co-ordinates, and the square root of the sum of their squares gave the distance along the boom at which the resultant pressure may be considered as acting. The determination of the vertical co-ordinate was perhaps the least precise of any of the characteristics, as its derivation involved the difference between the readings obtained with the arm at its original length and when shortened. In some cases this resulted in a small difference of two large quantities.

The components of the wind pressure on the sail acting along the wind and across the wind were derived directly from the equations and their resultant gave the resultant wind pressure in magnitude, direction, and point of application. Therefore it was possible to plot this resultant wind pressure in its true location and to scale for the different angles of boom to wind. The maximum resultant pressure occurred at an angle of boom to wind of 110 degrees, which was not unexpected when it is noted that the gaff was then at about 80 degrees with the wind and one might consider that the mean line of the sail was at practically 90 degrees. (All angles were measured up stream from the initial position of the boom.)

The maximum pressure with the wind at 15.1 miles per hour amounted to 0.885 pound per square foot, using the net area of the sail. It is probably more correct to include the projected area of the boom, mast and gaff and use the total area. This gives for the maximum pressure 0.833 pound per square foot. Eiffel's formula for the resistance of curved surfaces (camber 1 in 7) at 90 degrees with the wind, gives for this case 0.825 pound per square foot, which is an interesting agreement lying well within the accuracy claimed for either experimental work. It would seem that this formula of Eiffel's was applicable to the determination of maximum wind pressure for yachts, provided the area of spars, etc., is included in the area.

It is interesting to consider on what direction of sailing the ship is driven the fastest by this sail. If we assume that the hull resistance is the same for all courses and is not affected by different angles of heel, the course which is at 190 degrees with the wind is the one on which the boat will go the fastest. For this course the best angle which the boom should have with the center line of the boat is shown to be about 88 degrees. It should be remembered that this applies to the single sail rig only.

A very interesting point to be noted is that *for courses from 45 degrees to 160 degrees with the apparent wind* (shown by the fly at the mast head), *the angle between the boom and center line of ship for best sailing, with this sail, should be approximately one-half the angle between the fly at the masthead and the centerline of the ship.*

In all of the work so far considered no distinction has been made between real and apparent wind, but in applying the work to a yacht the wind which is customarily observed is that indicated by the fly at the mast-head. This is the apparent wind, and it is the resultant of the speed of the boat and the true wind. It is obvious that the wind of the tunnel experiments corresponds to the apparent wind. If it is desired to find the relationship between the apparent wind and the real wind or the relationship between the real wind and the courses, an estimate of the speed of the yacht in terms of the speed of the wind must be assumed, and then it will be possible to obtain the direction of the true wind.

Inland Navigation and Barge Construction Versus Floating Bridges

BY J. H. BERNHARD

ABSTRACT

In this paper the author takes the stand that the average Western river steamboats, costing \$70 (14/11/8) per net ton cargo capacity are of obsolete construction, and attributes the decline of transportation on the inland waterways very largely to the fact that naval architects have never put themselves seriously at work to replace these river steamers with more modern and economical carriers. As a solution of this problem, he describes the steel self-propelled barges of 1,000 tons carrying capacity, built according to his ideas for navigation between New Orleans, La., and Tuscaloosa, Ala. These boats have been operated successfully carrying freight over this route a distance of 1,050 miles and returning empty at a total cost of 40 cents per ton, or about $\frac{3}{8}$ mill per ton mile, one-tenth of the average railroad charge. In these boats the cargo is placed on deck, there being no hatches in the deck. By placing the cargo on the deck the entire hold is available for strengthening purposes and for placing the structural braces at the best possible advantage. The result was that very light material was used, the hull being built of $\frac{1}{4}$ -inch plate and the frames of $2\frac{1}{2}$ -inch by $2\frac{1}{2}$ -inch by $\frac{1}{4}$ -inch angle iron. Although the barge carries 1,000 tons net, there are only 170 tons of steel in her construction, and, together with the machinery, bunkers, etc., the total weight of the barge is only 240 tons. At full load these barges displace 1,240 tons of water, were given a speed of 8 miles per hour with only 150 horsepower, using for this purpose gas-producer engines burning breeze coke, which brought the cost down to 1/10 cent per horsepower per hour.

From this experience the author has recently organized a company for establishing a line of self-propelled barges on the Mississippi River. The barges will be divided into two classes—speedy and slow. The speedy barges will be 310 feet long, 56 feet wide and 9 feet deep, with a draft of 7 feet, propelled by four 600-horsepower engines, estimated to give a speed of 20 miles in slack water, 22 miles down stream, and $17\frac{1}{2}$ miles up stream. The slower barges, of which the first is now nearly completed, will be 240 feet long, 42 feet wide, capable of carrying 1,500 tons on a draft of 7 feet, and 500 tons on a draft of $3\frac{1}{2}$ feet. These barges were described in the November issue of INTERNATIONAL MARINE ENGINEERING.

Recent Progress with the Active Type of Gyro-Stabilizer for Ships

BY ELMER A. SPERRY

ABSTRACT

As the result of noteworthy experiments on board the U. S. S. *Worden* with the active type of gyro-stabilizer, it has been established that the gyroscope is useful in solving certain problems at sea, and orders have been issued by the Navy Department for fitting permanent plants, thus putting it into practical service. Since this work further investigations have been in progress. Among these have been determinations of the exact amount of the true wave increment the gyros are required to neutralize, involving the relation of the gyro-quenching increment to the natural extension curve of roll of the ship. It is gratifying to note that all of this work has proven the soundness of the basic formula originally laid down by Naval Constructor Taylor, in course of which he points out that gyro moment of stabilizer equipment for ships varies directly as the characteristic of the ship—i. e., the product of the displacement, the metacentric height and period of roll. There is no variation from this

rule involved in the fact that it has been definitely ascertained that small boats require relatively larger moments or greater stabilizing power than is the case with larger ships. This means that waves of given magnitude belabor small ships more than they do large ones, which is to be expected, and therefore require relatively more roll-quenching power to be fitted. Again, it is possible to adjust the plant in other ways to meet special conditions, such, for instance, as limited space, met with in the case of submarines; limited weight, which is the case where the gyro is placed on deck, as in the motor yacht *Widgeon*, and which is also the case with submarines; then again the condition where a limited power supply is available for spinning the gyro or gyros and handling the equipment.

Inasmuch as the roll-quenching power of the gyroscope varies as the square of its diameter and only directly as its speed and weight, and inasmuch as another factor—i. e., the power required for spin at the higher rates—varies almost directly as the cube of the peripheral velocity, it will at once be seen that where ample space is available and the matter of weight is not critical the rotor and spread of bearings may be so adjusted as to require a minimum of power for maintaining the spin of the wheel for a maximum of gyroscopic moment; and vice versa where only a limited space and weight are permissible and an abundance of power available, a small gyro spinning at higher velocity may be utilized for developing comparatively large stabilizing moments.

The first commercial gyroscope stabilizing equipment to be installed has been placed upon the yacht *Widgeon*, plying on the Great Lakes. This was placed in service in the autumn of 1915, and is of the full active type. The characteristics of the *Widgeon* are as follows: Displacement, 165 tons; metacentric height, 1.75 feet; period of roll, over and back, 4.75 seconds; waterline length, 120 feet; waterline beam, 18 feet 2 inches; total submerged midship section, 80 square feet.

For this ship the total weight of the gyro equipment is about one percent of the displacement. The yacht was looked upon as being a very free roller and after the gyro was installed it was found that when the gyro was thrown "off" a free roll of from 24 to 40 degrees of total arc was quickly developed while running in the trough of the sea, and when the gyro was thrown "on" this was quickly reduced and held at 2 or 3 degrees.

The details of the plant and the method of installation and operation are described in the paper. The system of control is practically identical with that which was finally adopted in the last experiments on the *Worden*—that is, a small auxiliary gyro is employed to feel out the incipient rolling of the ship by closing small electrical contacts as soon as the ship rolls very slightly one way or the other. These contacts are required to handle only a very few watts—in fact, about one-quarter of the energy of an ordinary incandescent lamp—and through a relay switch serve to actuate a small reversing motor which constitutes the precession motor. This motor precesses the gyro upon its main supporting gudgeons at the ends of the frame; it is here that the gyro lays hold upon the ship to control its movements. Inasmuch as all rolling of ships is due to an accumulation of individual wave increments, and since each increment is checked and neutralized, the ship never starts to roll and therefore never rolls.

The plant works very smoothly and practically without noise and seems to perform its duty easily. A little reversing switch provided with nameplates plainly marked "Rolling" and "Stabilizing" allows the stabilizer to be operated to roll the boat at will. This is useful in working off from sand bars, mud banks, negotiating ice packs, etc.

In fact, this has already been found extremely serviceable in the shallow waters of Toledo inlet.

Other points that have been definitely settled by the operation of the stabilizer are as follows:

That under conditions of a strong wind which had been blowing all day, with Government storm warnings hoisted all along Lake Erie, a trip was made from Toledo to Cleveland in the evening where with the gyroscope "off" the ship rolled up to 25 degrees each side of the vertical, and with the gyroscope "on" this roll was quenched down to an average of 3 degrees or less, the interesting point being that the boat steered very much steadier and made her run in as good time as on any previous trip, including calm seas, and also while being stabilized her decks remained dry. It is gratifying to note also that the chief engineer and others who reviewed the operation of the plant have reported that they are satisfied that it is "thoroughly practicable and that there will be no difficulty in keeping it in proper operating condition."

Variation of Frictional Resistance of Ships with Condition of Wetted Surface

BY NAVAL CONSTRUCTOR WILLIAM MCENTEE, U. S. N.

ABSTRACT

Considering that frictional resistance is the most important element in the resistance of practically all ships, it is noteworthy that investigations of conditions affecting it have been relatively few. Although there have been many attempts made to reduce this resistance by different methods and there are many references made to its increase from fouling, there appear to be relatively little actual data as to the quantitative variations obtained. The results here given are based on a series of tests made at the United States Experimental Model Basin during a period extending somewhat over a year.

In considering this general subject, two queries naturally arise: (1) On actual ships, what is the increase in resistance due to fouling? (2) Is it possible to reduce the frictional resistance by modifications in the condition of the frictional surface, or by the application of materials which would tend to make the surface smoother?

EFFECT OF FOULING

The method adopted to investigate this subject was to expose to fouling in sea water twelve 10-pound steel plates 2 feet wide by 10 feet long, painted with two coats of anti-corrosive paint. The plates were placed in the water July 10, 1914, at a point in the Chesapeake Bay near the navy yard, Norfolk, Va., where the water ordinarily has a density of 1.02—that is, contains about 75 percent as much salt as is ordinarily found in sea water.

The plates were removed from the water at intervals

of one month, carefully packed so as not to remove any of the fouling, which consisted mostly of small barnacles, and shipped to the Model Basin, where they were tested to obtain the frictional resistance.

Each plate as received at the Model Basin was tested at speeds ranging from $1\frac{1}{2}$ knots to 8 or 9 knots, and gave results shown in Table I. After this the plate was carefully cleaned, scraped and repainted with a coat of Norfolk anti-fouling paint and retested at the same range of speeds as when fouled, and the coefficient and exponent for the clean condition determined. The fouling matter removed from the plates was weighed so as to give a measure of the amount of fouling.

It will be seen that the maximum increase is such that the resistance when foul is four times as great as when the plate is clean and freshly painted.

Referring to Table I it will be seen that not only does the coefficient of friction increase greatly, but that the exponent in the formula, $R = SfV^n$ also increases and has a value averaging about 2.00 as compared with the value of about 1.88 for the clean plates.

These results indicate the importance of keeping a vessel's bottom clean and well painted, though it is not considered that the relative effect on a ship's resistance due to an equal amount of fouling would actually be as great as that obtained in these experiments, as it seems probable that the decrease in frictional coefficient due to increase of length would be relatively greater for the foul condition than is found to be the case for clean, smooth surfaces.

EFFECT OF LUBRICATION

At various times attempts have been made to reduce the frictional resistance of ships by lubricating the underwater surface or by polishing it to a high degree of polish with various materials. One favored method used for racing yachts is to polish the bottom with black lead or graphite. An investigation of the benefits to be expected from such polishing or lubrication has recently been made at the Model Basin with two friction planes, which were roughly 20 feet by 2 feet by $\frac{3}{4}$ inch, with ends sloped forward at an angle of about 30 degrees. Total wetted surface for each is about 82 square feet. The planes were sandpapered smooth and coated with shellac, and in this condition were each towed in the water at speeds ranging from 1 to 11 knots.

One plane was next coated with black lead or graphite, which was mixed in sour milk and applied with a brush to the shellacked surface of the plane. When dry the lead was rubbed down to a fine, smooth polish. Ten runs were made with this plane at speeds from 5.1 to 6.5 knots. The graphite seemed to cling well to the surface and showed no abrasion or wear. When wet, however, it was easily rubbed off.

TABLE I.—TABLE SHOWING INCREASE IN RESISTANCES OF PLATES WHEN FOUL AS COMPARED WITH THE SAME PLATES CLEANED AND FRESHLY PAINTED.

MONTHS IN WATER. SPEED KNOTS.	INCREASE IN RESISTANCE IN POUNDS.											
	1	2	3	4	5	6	7	8	9	10	11	12
2.....	0.24	0.40	1.17	2.09	2.50	2.52	2.80	2.76	2.61	2.97	3.09	3.36
3.....	0.72	0.88	2.83	4.94	5.79	5.72	6.45	6.31	6.17	6.93	7.28	7.78
4.....	1.48	1.56	5.19	9.09	10.53	10.22	11.79	11.38	11.02	12.75	13.39	14.20
5.....	2.55	2.45	8.41	14.59	16.71	16.08	18.55	18.03	17.32	20.30	21.40	22.50
6.....	4.02	3.54	12.42	21.40	24.32	23.20	27.20	26.16	25.13	29.83	32.43	33.07
7.....	6.77	4.74	17.35	29.60	33.45	31.70	37.00	35.95	34.23	41.15	43.4	44.65
8.....	7.82	6.20	22.90	.....	44.20	41.60	48.65	47.50	44.80	54.50	56.8	60.10
9.....	10.40	7.75	29.40	.....	56.35	52.85	.....	.....	56.95	69.85	.....	.....
10.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Coef. foul plate.....	0.01138	0.01282	0.01667	0.0239	.0255	.0252	.02745	.02666	.0275	.0285	.0273	.0292
Exp. foul plate.....	1.994	1.928	2.029	2.002	2.003	1.988	2.000	2.000	1.967	2.015	2.055	2.035
Coef. painted plate.....	0.01071	0.01004	0.01000	0.01189	.0108	.0095	.0108	0.01013	.01075	.00903	.0096	.0095
Exp. painted plate.....	1.869	1.918	1.937	1.855	1.874	1.938	1.880	1.912	1.869	1.848	1.914	1.924

Coef. = Coefficient. Exp. = Exponent in formula $R = SfV^n$.

The next material tried was ordinary Ivory soap, which was mixed as a thick emulsion in water and applied with a brush. The plane was run at speeds from 6 to 9 knots. The soap left a whitish streak in the water the first run, but not thereafter. The resistances obtained on all of the runs were consistent, so that the quality of the surface was probably unchanged during the course of the experiments.

Two other lubricating materials experimented with were heavy cylinder oil and light cylinder oil. The oil was applied to the shellacked surface of the plane when dry with a brush, the plane being suspended over the position in which it was attached to the towing carriage, so that it could be run in the water as quickly as possible after the application of the oil. The plane with the heavy engine oil was run at speeds from 6 to $8\frac{1}{2}$ knots. The observations obtained were consistent, but the slope of the resistance line when plotted on log paper indicated that at speeds of about 3 knots the frictional resistance would fall below that of the smooth, shellacked surface. This peculiarity is possibly due to the fact that parts of the oil formed in drops or globules and wavelets, increasing as the speed increased, thus changing the condition of the surface which might, if tested at lower speeds, not have given results lower than shellac.

The experiments with the light engine oil indicated that for the first two runs the resistance was a small percentage greater than for the shellacked surface. Apparently as the oil was washed off the resistance decreased until the resistance agreed with that previously obtained with shellac.

The results of the experiments indicate that no advantage over a smooth varnish or shellacked surface is obtainable with the materials used. For each lubricating surface the resistance is greater than for the shellacked surface. The resistance increases in the following order: Black lead, light engine oil, Ivory soap, heavy cylinder oil.

The lubricating surfaces were tried only over a limited range of speeds, from 6 to 9 knots, as it was thought that the exponent in the formula $R = SfV^n$ could not be used, owing to the changing condition of the surface due to the washing off of the lubricating material. Actually it was found, however, that the light engine oil was the only material for which the resistance changed rapidly, and that washed off quickly so that the resistance came down to that for shellac.

In Table II is given a tabular comparison of the results:

TABLE II.—WITH CONDITION OF WETTED SURFACE.

SURFACE.	Plane.	Area Sq. Ft.	Coef. of Friction.	Exponent.	Net Resistance at 7 Knots in Lbs.	Percentage Increase in Resistance at 7 Knots.
Shellac.....	AB	82.12	.00878	1.883	28.1	....
Shellac.....	CD	82.20	.00849	1.886	27.4	....
Black lead.....	CD	82.20	.00866	1.886	27.9	2
Light engine oil.....	AB	82.12	.....	.....	28.3	5*
Ivory soap.....	AB	82.12	.01045	1.898	34.5	23
Heavy cylinder oil.....	CD	82.20	.00484†	2.38†	40.5	48

* At 6 knots.

† This low coefficient of resistance is combined with a high velocity exponent and probably would become greater at speeds lower than those at which experiments were made.

The Determination of the Resistance of Ships;—Present-Day Status of the Art

BY ERNEST H. RIGG

This paper gives a very general résumé of published information bearing on the effect on resistance of increased beam, the effect of wind and sea, shoal water and temperature and the appendage resistance and the advantage of adopting cruiser sterns. The author calls attention to

the desirability of a uniform system of notation throughout technical literature and recommends the system used by Taylor and Sadler, as it is ample, clear and direct. He also points out the advantage of testing in a model tank models of practically every naval or passenger vessel and enough models of cargo vessels to cover a useful range of types so that each shipyard can know whether their "lines" are good and make improvements from time to time as experience points out. The paper is briefly summed up with the following recommendations: For large cargo ships and practically all motor ships a twin screw drive is the most efficient. Further light is desirable on vibration problems, especially for vessels with machinery aft. Speed and stability are intimately associated and generally pull at cross purposes: the temptation to small beam, high speed and comfort at sea for passengers may be yielded at the price of safety in accidents. The passing of the very full cargo ship in favor of a somewhat finer type is commendable. Cruiser sterns for twin or triple screw ships are decidedly to be preferred to the older type of counter. Appendage resistance is generally very small in single screw merchant ships, but cannot be watched too carefully in multiple screw and faster types. Closed shaft bossings are generally preferable to open brackets. Progressive trials should always be made of important ships and of enough cargo ships in load condition to check up model tank and propeller performances. Flared bows above water are now well established and undoubtedly improve performances at sea. Large apertures with propellers well back from the post and ability to unship propellers without withdrawing the tail shaft are to be strongly recommended.

An incomplete bibliography is added which is intended to cover the subjects taken up in the paper.

Results of Model Tank Experiments to Determine the Action of a Ship Brake

BY CAPTAIN WM. STROTHER SMITH, U. S. N.

ABSTRACT

This paper is presented with the idea of showing the interesting data obtained in the model tank at the Navy Yard, Washington, for use in determining whether or not it was feasible to design and install a brake on the side of a merchant vessel to assist in stopping a steamer when in danger of collision or grounding. The Wm. Cramp & Sons Ship & Engine Building Company furnished the lines of the steamship *St. Louis*, and a model of this vessel was constructed. The steamship *St. Louis* is 536 feet in length, 62 feet 9 inches beam, and the draft at load line was 28 feet for model experiments, the displacement being about 17,230 tons.

Three runs were made to determine the curve of speed and power before fitting any brakes, and the ten successive runs were made with different areas and settings of the brake to determine the resistances and pressures per square foot.

The following deductions are made:

The stopping power varies directly as the projected area opposed at 90 degrees to the fore-and-aft line. One pair of brakes is more efficient than two. The pressure per square foot practically decreases as the width of the brake is reduced and, by plotting curves of pressures at various speeds for different widths of brake, it is found that after a certain width is passed the pressure per square foot is not increased.

Using a pair of brakes 11.73 feet wide and 14 feet deep set normal to the direction of the vessel, the speed being 18 knots, the speed will be reduced to 15.2 knots in 500

feet, to 11.6 knots in 1,000 feet, to 7.15 knots in 2,000 feet without the assistance of the propellers in backing.

Assuming the weight of the vessel at 17,230 tons, the striking blow at 18 knots equals 247,300 foot second tons, 15.2 knots equals 176,300 foot second tons, 11.6 knots equals 102,700 foot second tons, 7.15 knots equals 39,000 foot second tons.

Using the element of time, the speed will be reduced in 50 seconds to 11.1 knots, 100 seconds to 7.35 knots, 150 seconds to 5.85 knots, 200 seconds to 4.70 knots.

To satisfy the ideas of many concerned, various forms of the brake were considered, principally with the idea of controlling the brake by power so as to open and close at will, the vessel going at full speed. The final conclusion reached—that the simplest form of brake designed to be set in the side of a vessel, to be released instantly by the officer on the bridge by throwing a lever and open by the pressure of the water without further thought; to be supplied with only enough power and mechanism to haul in the brake when the vessel was stopped or going astern and lock it fast for future use—was the only practical solution of the question. With these points in view, a type design was made for the Canadian Pacific steamship *Empress of Asia*, practical, strong and simple, for emergency use only. The officer on the bridge has but to pull a lever and the brake will open and exert its resistance. When the danger is past it requires but the attention of one man on each side to haul in and secure the brake.

Some Comparisons Relating to Electric Propulsion of a Battleship

BY W. L. R. EMMET

ABSTRACT

The Navy Department of the United States has awarded to the General Electric Company of Schenectady, N. Y., a contract for electric propelling machinery for the new battleship *California*, which is being built at the New York Navy Yard. This ship is of the largest and most powerful class which has been adopted by the United States. Her displacement is 32,000 tons and her maximum speed is to be about 22 knots, requiring about 37,000 shaft horsepower. The contract with the General Electric Company covers two turbine-driven generating units, four propelling motors (one for each shaft), switching apparatus, cables, instruments, etc., two turbine-driven exciting units, and a complete equipment of condensing auxiliaries and ventilating blowers, all driven by motors from the exciting units. In fact, it covers practically the entire engine-room equipment except the main condensers.

Each of the auxiliary units is of 300 kilowatts capacity with a 240-volt direct-current generator geared to a high-speed, non-condensing turbine. These turbines will exhaust into the heaters, into the main turbines, or both. The motors which drive the auxiliaries will be designed for a considerable range of speed variation, so that the auxiliaries will be adaptable to economical conditions at different speeds of the ship.

The generators for the *California* are bipolar alternators, and the motors are arranged to be connected either for 24 poles or 36 poles. For economic cruising at 15 knots or less, one generator will be used with motors on 36-pole connection. For higher speeds the 24-pole connection will be used. The ship will be capable of operating at a speed of about 18.5 knots with one generator.

Speed variation with either motor connection will be effected by change of turbine speeds through the agency of variable speed governors designed to hold automatically any desired speed within usual ranges. This arrangement,

which is also used in the *Jupiter*, entirely prevents racing and makes it convenient to hold a fixed speed irrespective of variations in sea, weather or steam conditions. It is thought that this feature will be valuable in fleet formations.

The steam consumption guaranteed on the *California* covers the total steam required for the main turbines and engine-room auxiliaries as described above. The conditions are 250 pounds gage pressure, dry steam, with such vacuum as can be produced under trial conditions. The guaranteed water rates per horsepower delivered to the propeller shafts are as follows:

	Pounds
At 10 knots.....	14.6
At 15 knots.....	11.4
At 19 knots.....	11.1
Maximum speed.....	11.9

Very heavy penalties are imposed in case these guaranteed consumptions are exceeded in trials, \$25,000 (£5,100) per pound for the two lower speeds and \$20,000 (£4,100) per pound for the two upper speeds.

At full speed the *California* propellers will make 175 revolutions per minute, this being about the lowest speed of propellers which is practicable within the space. The propeller speeds proposed for the sister ships with Parsons turbine drive is 240 revolutions per minute, and comparisons by Dyson's method indicate that this speed difference will give the *California* an advantage of about 9 percent in propeller efficiency.

The following table gives a comparison of steam consumption per effective horsepower between the *California* as guaranteed, the *Florida* and *Utah*, which are driven by Parsons turbines, and the *Delaware*, which is driven by reciprocating engines. These figures are taken from the published records of trials.

	POUNDS OF STEAM TO MAIN ENGINES PER HOUR PER E. H. P.				
	12 knots	15 knots	19 knots	21 knots	Prop. speed 21 knots
<i>Florida</i>	31.8	...	24.0	23.0	328
<i>Utah</i>	28.7	...	20.3	21.0	323
<i>Delaware</i>	22.0	...	18.7	21.0	122
<i>California</i>	17.3	15.2	15.0	16.4	175

Such a table as this affords the truest basis of comparison of prime movers in ships. The estimated weight of the propelling machinery without condensing auxiliaries is 530 tons, and that of the turbines originally proposed was 653 tons.

The contract price for the *California* propelling machinery with auxiliaries given above is \$431,000 (£88,500). The estimates made at the New York Navy Yard indicate that this equipment will cost \$200,000 (£41,000) less than the Parsons turbine equipment previously considered.

Interior Decoration of Vessels

BY HARRY B. ETTER

ABSTRACT

The traveling public of to-day demand and are willing to pay for pleasant surroundings and comfort whether by land or sea. It is true that they get it on most of the transoceanic liners, but with the American coastwise steamers, with some notable exceptions, they are not so fortunate. I do not wish to criticise these steamers too harshly, but they are for the most part ugly from a decorative standpoint. The joiner work has to be made to suit the vessel, and it could have just as well been made to follow some good design instead of a riot of meaningless panels, moldings and pilasters. The joiner work of most of these vessels is very often of the same design from end to end, bottom to top, and bad proportion at that. It must be trying to one of refined taste to have the same

thing staring at him every place he goes for a week or so.

In working out a successful design for an interior a great many things should be considered, and care should be exercised not to have the decoration of adjoining public rooms so one will shock the other. All should blend together like one complete thing and yet not be alike. Other things to be considered are: First always, meaning; followed by balance of line, light and shade, repetition, variety of surface, choice of material, contrast and harmony of color and suitability for the trade the vessel is to engage in.

Exquisite form and proportion must be gained by extreme simplicity of beauty of line in the division of a wall surface into a series of panels, borders and moldings, separated by pilasters, columns and other architectural forms.

Simple designs well proportioned are an attraction in themselves, and an excess of elaboration should be carefully avoided. Mixture of styles does not always secure the best results. Ornaments, if used, should not attract the eye to the exclusion of the background as if it were an entirely separate part, but should be subservient to the general effect.

Furniture, upholstering, draperies, etc., should be carefully selected to harmonize with the style of the room. Too often is this neglected and a truly beautiful room spoiled by unsuitable furnishings. The designer of the decoration, if he knows his profession, can be and should be consulted in regard to all details, as he can picture in his mind what such things should be as he progresses with his work.

The interior decoration of a vessel is very often unsuited for the climate she is to trade in. While we do not want dark, hot-looking rooms for tropical climates, but something cool and airy, just the reverse may be said for vessels engaged in the colder regions. If a period of decoration is to be adopted we should stick to it not only in line, but in colors and material, both woods and woven goods. Some of the periods of decoration which are most pleasing and well adapted for ship interiors are Louis Quatorze, Regency, Louis Quinze, Louis Seize, French Empire, Elizabethan, the Georgian periods, Adams, American Colonial and some others not so well known by those who are not connoisseurs of art. Some of the Italian styles are beautiful and are especially suited for first-class yacht work, as they are fine as to detail, mostly always carved and consequently more costly.

As smoking rooms are mostly always finished in oak, some of the sixteenth century English or Flemish styles always look well and make an agreeable change from the lighter and gayer styles employed for a music room or lounge. For outside rooms, such as a veranda or enclosed promenade deck, palm room and the like, a garden effect with trellisage panels can hardly be improved upon. Stateroom corridors and alcove passages as plain as possible are better than a lot of small panels and fancy moldings. In the stateroom corridors on the Cunard steamer *Aquitania*, panels are eliminated entirely. The walls are built of tongued and grooved planks finished smooth and covered with a light canvas stretched on and painted, with pilasters at doors and corners only. Stateroom division bulkheads, if also built this way, would make all four walls alike in the room. The dead white enameled walls of the average stateroom are too glaring. The flush walls mentioned above would prevent this. We do not need to have carving or ornaments to make a thing attractive. To begin with, carving is a dirt collector, and unless one can afford to have it well executed it had better not be attempted.

Proportion is an important consideration. As the deck

heights are usually too low for the size of the room, the walls should be designed to deceive this and give the impression of height. This can be greatly improved by keeping the chair rail, if there be one, as low down as possible, thereby making the upper panels the longest and preventing the squat look. Columns and pilasters should be well proportioned and with caps and bases suitable for the shafts. Cornices and moldings should have a defined profile. Panels should be large and, when made of several ply wood or one of the many kinds of composition, will not warp or crack. Small panels or those running in a brick fashion have a gingerbread look and require more labor to put together, which adds to the cost and lacks appearance. If a hung type of ceiling be employed—that is, one framed under the deck beams—it should be carefully treated.

There are many difficulties to be dealt with in interior ship decoration, caused by the shape of the vessel, the structure, the crown of the decks, the sheer, the low deck heights and the smallness of the air ports and deck-house windows. The shape of the vessel necessarily has to stand, as well as the structure for the most part. But here many of the difficulties caused by the structure could be avoided if those in charge of the structure and decoration would work together and a little flexibility exercised, together with a little judicious scheming. Stanchions, girder lines and web frames can almost always be placed to suit architectural requirements without sacrificing the strength of the vessel.

The low deck heights, being all out of proportion to the size of the average room, are hard to treat and require resourcefulness unless the public rooms are under the boat deck. If the deck heights will permit it, a good practice is to hang the ceiling under the beams, with large panels and false beams to suit the design of the room. With the hung ceiling it is possible to carry ventilation ducts, pipes, electric wiring, etc., above it and out of sight, to which access can be had where desired by having some of the panels made so that they can be taken down without disturbing the remainder of the work. With a ceiling of this type it can be better treated to suit the period of design chosen for the room and will also serve better to reflect electric lighting by avoiding the deep shadows between the beams.

Air ports and deckhouse windows by the smallness of the openings usually form a problem hard to treat. The inside sash sometimes employed helps matters a great deal. Ports and windows, if worked in pairs, can be treated as a large double window and look better than if spaced singly and equally distanced all around the walls, as so often seen. With the height of large steamers above the water, it is possible to employ large, metal-framed windows especially designed to suit the interior. This is being done on most of the transatlantic lines with great success when the location is not too much exposed to the elements.

Too much care cannot be taken in working out the staircases. The stairs in most vessels are too steep and winding. Winding stairs look attractive only on a plan. Thwartship flights should be avoided as much as possible, as in descending such flights one has to meet the rolling motion of the vessel. The proportion of the width of tread to the height of the riser should be carefully worked out. A good rule is to have the sum in inches of one tread and two risers to equal as near as possible to 24 inches, the width of the tread taken always without the nosing. A good proportion would be 7 inches for the risers and 10 inches for the tread. In no case should the tread be more than 12 inches wide or the risers less than 6 inches high. As the staircase in most vessels is generally a principal

feature, care should be taken to have it of a good design, with balusters or grille railing corresponding to the design of the surrounding joiner work.

As artificial lighting has more than ever become a strong decorative feature since the advent of electric lighting, a few remarks here would not be out of place. Soft lighting effects are the cry of the present age and the light bulbs, if covered with globes of the many artistic designs manufactured (keeping in mind, of course, the style of the room), will produce this effect. As a vessel's saloons are rarely high enough to successfully have indirect lighting, the wall bracket can be used to a great advantage. When ornamental glass panels are fitted at the ceiling level of skylights or in dome skylights, the lighting of the room is always greatly improved if lights are fitted behind them. Otherwise the skylight makes a black patch at night and puts the whole middle of the room in shadow. The writer believes that the light should come from the same direction by night as by day.

Data on Hog and Sag of Merchant Vessels

BY T. M. CORNBROOKS

ABSTRACT

In a paper read before this society in 1913, Naval Constructor S. F. Smith presented considerable data showing observations made on three navy colliers built by the Maryland Steel Company, to which were added the data of the two colliers built by the Newport News Company. Since that time two additional colliers have been constructed for the Panama Canal. These colliers are of the same general dimensions as the *Orion* and *Jason*, but of increased deadweight capacity.

The *Ulysses* and *Achilles*, Panama colliers Nos. 1 and 2, are built from the same lines as the *Orion* and *Jason*, but to secure the necessary capacity for coal the machinery was moved aft 15 feet and the 'thwartship coal bunkers reduced 10 feet in length, making the holds 25 feet longer. The contract for these vessels required that they should carry 12,000 tons of cargo, 1,200 tons of bunkers and 105 tons of stores, feed water, crew and effects, on a draft of 28 feet 1 inch. As a matter of fact, they drew 27 feet 8 inches when loaded with the above deadweight.

Following the methods used in securing the data on the previous colliers, we started by establishing a datum line by transit while the vessels were on the stocks and supplemented this by readings taken immediately after launch, when machinery was installed, when in dock, before loading and when fully loaded. When fully loaded the *Ulysses* sagged $2\frac{1}{8}$ inches and the *Achilles* $2\frac{1}{16}$ inches from the original datum line, as compared with $3\frac{7}{8}$ inches on the *Neptune*, $2\frac{15}{16}$ inches on the *Orion* and $3\frac{3}{16}$ inches in the *Nereus*. The difference in the amount of sag between the *Orion* and *Jason* and *Ulysses* and *Achilles* can probably be accounted for by the better distribution of cargo.

Two curves are shown of the *Achilles*, of the ship completed—i. e., May 10 and 20. These observations were taken under the dates noted to determine the deflection while the forward oil tanks and double bottoms were filled with water as itemized, in preparing for a test of the oil-pumping capacity. The results show considerable hogging effect when compared with the *Ulysses* when completed under date of March 15, which can be accounted for by the different conditions of tank loadings.

In addition to the curves taken on the *Orion* and *Jason*, observations on the *Achilles* were taken for determining the deflection of the hull in way of the forward oil holds, when under hydrostatic test.

Period of Vibration of Steam Vessels

BY WILLIAM GATEWOOD

ABSTRACT

The author was led to investigate this subject by the vibrations which occurred in service on an oil tanker built by the shipyard with which he is connected. This tanker is 460 feet long and is fitted with a quadruple expansion engine installed in the stern, designed to indicate about 2,800 horsepower at 78 revolutions per minute. When running in ballast condition, no vibration was experienced. When loaded, however, longitudinal vibrations in a vertical plane were experienced with the engines turning at revolutions between 72 and 76. These vibrations were of the two-nodal character, and their period corresponded with the revolutions of the main engines. After several trips the pitch of the propeller was increased so that the revolutions in service might be less than 72, and under the altered conditions no vibration was experienced.

In order to investigate the matter more thoroughly, however, observations were taken on the vessel after the pitch of the propeller had been increased. The methods of taking observations were somewhat primitive and consisted of a device for measuring variations in the shape of the vessel in a vertical plane and another device for measuring the change in length of the deck plating.

The observations took place in the Gulf of Mexico in July, 1914, with the vessel loaded with about 11,000 tons, deadweight. The revolutions of the main engine were increased from 68 to 74, when a slight vibration became noticeable. When the revolutions were increased to 76, the vibrations were quite appreciable. The motion amounted to about $\frac{1}{2}$ inch total. It was difficult to determine this with exactness, as it varied slightly, but it never appeared to exceed $\frac{3}{4}$ inch, and $\frac{1}{2}$ inch seems near the true reading. The number of vibrations corresponded with the revolutions of the engine. The type of vibration was of the two-nodal character, in which the bow and stern drop as the midship portion of the vessel rises, and rise as the midship portion drops. The nodes seemed to lie near the after end of the bridge deck-house and at the after cofferdam, but it was difficult to decide where the nodes were. The variation in stress in the shelter-deck stringer corresponding to $1/16$ inch variation in length in 90 feet amounts to about 1,700 pounds per square inch. The deck was already in compression, and the additional compressive stress therefore amounted to about 850 pounds per square inch.

During the tests the sea was smooth. When the engines were slowed down the vibrations ceased. When the revolutions were raised to 76 again, so that indicator cards might be taken, the vibrations reappeared, and of the same intensity as before. Here seemed to be a case of synchronism between the revolutions of the main engine and the period of vibration of the hull structure occurring in the working range of revolutions of the engine on a vessel of low speed.

The Application of Small Steam Turbines for Auxiliary Purposes on Board Ship

BY W. J. A. LONDON AND FREDERICK D. HERBERT

ABSTRACT

In marine work we have seen the gradual elimination of the reciprocating engine for practically all classes of work by the turbine. The turbo-generator has become practically the standard unit for electrical production in all navies and merchant marine, so that little need be said about this application at the present time. The really interesting phase of the small turbine situation to-day,

however, is in the wider application of this machine. The small turbine is now successfully employed for the following purposes: (1) Generator sets, (2) wireless sets, (3) forced draft blowers, (4) circulating pumps, (5) hot well pumps, (6) ash ejectors, (7) induced draft fans, (8) ballast and service pumps.

The three new battleships, the *Arizona*, *Mississippi* and *Idaho* are being equipped with turbine auxiliaries as follows:

The paper discusses at length the application of the

The situation as regards superheaters and the use of highly superheated steam is summed up by stating that designs suitable from the standpoint of efficiency, simplicity, accessibility and durability are available for ship owners. The difficulties which discouraged the earlier designers have been overcome as regards detail designs and operating conditions, and therefore the installation, operation and maintenance of high degree superheaters appear to be not only possible, but practical and beneficial in marine practice.

Type.	ARIZONA.						MISSISSIPPI.						IDAHO.					
	No.	Steam Press.	Back Press.	Speed R.P.M.	B.H.P.	D. C. or Geared.	No.	Steam Press.	Back Press.	Speed R.P.M.	B.H.P.	D. C. or Geared.	No.	Steam Press.	Back Press.	Speed R.P.M.	B.H.P.	D. C. or Geared.
Dynamo condenser pumps		Lbs.	Lbs.				2	Lbs.	Lbs.				2	Lbs.	Lbs.			
Boiler feed pumps		250	15	3000	180	D. C.	3	295	15	1275	15.8	D. C.	2	200	26	1275	14.4	D. C.
Forced-draft fans	2	250	15	1550	32	D. C.				3000	144	D. C.	3	230	15	3000	174	D. C.
Main circulating pumps										3620			9	250	10	1550	46	D. C.
Distiller circulating pumps							2	265	20	850	460	Geared	2	230	5	1350	347	D. C.
							2	295	8	2000	13.2	D. C.	2	250	8	2000	12	D. C.

small steam turbine to blowers and pumps and the detail design of small steam turbines. These applications will be taken up in detail in a later issue.

The Maintenance of the Fleet

BY CAPTAIN A. P. NIBLACK, U. S. N.

ABSTRACT

In this paper the author strongly urges the fortification and equipment of island bases in the Pacific Ocean at such points as Guam, Tutuila, Midway and the Aleutian Islands. To show the necessity of such naval bases as auxiliary centers of supply and security, he assumes as an illustration that a United States naval fleet of thirty battleships, twenty cruisers, forty destroyers, twenty colliers, three supply ships and a fleet repair ship is assembled off Panama to make a leisurely voyage to Manila and return by way of Honolulu, Midway and Guam. The margin of fuel supply on these vessels for the successful completion of this voyage, even at slow speed in times of peace, when no bad weather is encountered and there are no delays from breakdowns, is shown to be extremely small. In the event of war, however, the high speed required in scouting and protecting would increase enormously the demand for fuel, and in order to make such a voyage under these conditions, the proposed fortified island naval bases would become a practical necessity.

Superheated Steam in Marine Practice

BY HENRY B. OATLEY

ABSTRACT

The subject is treated under separate headings dealing with superheater development, superheater design and construction, engine conditions with superheated steam, engine operation with superheated steam, equipment necessary for superheated steam operation and difficulties to be overcome and advantages to be gained by using superheated steam. In marine practice during the last fifteen years over 1,200 ships have been fitted with superheaters, all using 150 degrees of superheat and the majority operating with practically 200 degrees superheat. The author does not consider it an exaggeration to state that, at the present time, well over 2,000 steamers are afloat using superheated steam, the majority of which are operating with what can be classed as "high superheat"—that is, above 125 degrees.

In discussing the design and construction of superheaters, three different classes are considered: separately fired superheaters, waste gas superheaters and live gas superheaters. The various types of superheaters coming under these classes which have been used commercially are described and illustrated in detail. In the operation of engines with superheated steam, one of the main considerations is lubrication. The keynote of the lubrication question with highly superheated steam is that a regular supply rather than a large quantity of oil is required. The oil furnishes the lubrication previously afforded by the water present in the saturated steam, but it does not follow that a regular supply of oil means a large quantity of oil. The special equipment required for handling superheated steam includes a lubricating oil pump and pipes, filters, pyrometers and mixing pipes for leading saturated steam to the main steam pipe and superheated steam to the auxiliary steam pipe. In a superheated steam installation the steam pipes, stop valves and feed should contain no copper or brass. Many governmental regulations prohibit cast iron and malleable iron. In any event, the steam pipes and flanges should be well insulated. Steam chest valves on the high-pressure cylinder should be of the piston type with rings wherever the degree of superheat is sufficient to eliminate all condensation through the first cylinder. Engine cylinders and liners must be of first-class, close-grained cast iron as hard as can be worked. The piston rings should be of strong, hard cast iron.

With superheated steam the question of cylinder ratios becomes important. The published dimensions of English and German steamships using superheated steam show that a lower cylinder ratio is used than with saturated steam. This is generally accomplished by increasing the diameter of the high-pressure cylinder, the intermediate- and the low-pressure diameters on a triple expansion engine remaining as before. In converting saturated engines to the use of superheated steam, an increase in the high-pressure cylinder diameter is not always advisable, and many times not possible. In such cases, if the same indicated horsepower is to be obtained, it is necessary to increase the cut-off in the high-pressure cylinder, thus giving an increased volume of steam at the cut-off and in effect decreasing the cylinder ratio.

The recognized advantages for ship owners in using superheated steam are summed up as follows: Fuel and water economy, reduced valve leakage, increased boiler capacity and increased revenue cargo space.

The Submarine of To-Day and To-Morrow

BY L. Y. SPEAR

ABSTRACT

Owing to the secrecy imposed by war conditions, the number of boats built or building to-day is not definitely known, but the best information available indicates that about 350 have already been completed and that about 200 more are now under construction. The growth of the mechanical development of the submarine may perhaps be best illustrated by a comparison of the characteristics of one of the first successful boats with those of a recent type. The principal characteristics of these two designs designated as "A" and "B" are set forth in Table I:

TABLE I

	Type "A" 1900	Type "B" 1914
Length	53' 10"	230' 6"
Beam	10' 3"	21' 6"
Surface displacement, tons.....	67	663
Submerged displacement, tons.....	75	912
Horsepower, surface	50	2,000
Speed, surface, knots.....	6	17
Horsepower, submerged	50	980
Speed, submerged, knots.....	5½	10¾
Radius action, surface, knots.....	200	3,000
Number torpedo tubes.....	1	8

The comparative figures given in Table II are of interest as showing the improvement resulting from ten years of step by step development:

TABLE II

	Type "A" 1900	Type "B" 1914
Horsepower main engines.....	50	2,000
Pounds per horsepower.....	78	48
Fuel consumption, pounds per horsepower.....	.74	.50
Horsepower electric motors.....	50	980
Pounds per horsepower.....	57	48
Pounds per horsepower of storage battery.....	909	216

As noted above, type "B," for the design of which the author is responsible, has been selected as fairly representative of the best results actually achieved to date in the mechanical development of the submarine. The representative character of the figures will be corroborated by an examination of the characteristics of the contemporary vessels in the English and German navies, viz., the English "E" class and the German "U-21 to U-32" in Table III, as well as such data as are available with respect to the German class "U-33 to U-42," which have been commissioned since the outbreak of the war.

TABLE III

	Type "B"	English Type "E"	German "U-21 to U-32"	German "U-33 to U-42"
Length	230' 6"	175'	213'	223'
Surface displacement, tons.....	663	730	640	665
Submerged displacement, tons.....	912	825	787	822
Engines	Diesel	Diesel	Diesel	Diesel
Horsepower, surface	2,000	1,600	1,800	2,300
Speed, surface, knots.....	17	15-16	16	17
Speed, submerged, knots.....	10¾	9-10	10	10
Armament, torpedo tubes.....	8	6*	4*	5*
Armament, guns	0	2	2	2

* Doubtful.

Counting, then, only such boats as are actually in active commission and of proved qualities, we may sum up this phase of the subject by saying that from the point of view of mechanical development "the submarine of to-day" connotes a vessel of the following approximate characteristics:

Surface displacement.....650 to 750 tons
 Submerged displacement.....800 to 900 tons
 Surface horsepower.....1,600 to 2,300
 Surface speed.....15 to 17 knots
 Submerged speed.....9 to 11 knots
 Armament.....2 guns of from 3 to 4 inches caliber and 4 to 8 torpedo tubes

The wide radius of action of such boats and their ef-

iciency when operating submerged at long distances from their base have been amply demonstrated in the present war, as in the exploits of the English "E" boats in the Dardanelles, the Baltic and the North Sea, and the similar work of the German boats "U-21 to 41" in the North Sea, the Atlantic and Turkish waters.

Considering the "submarine of to-morrow" from an engineering standpoint, assuming certain speeds, radii and armament as rigid requirements, it is obvious that the displacement must vary according to the type of machinery installed and the amount of attention paid in the design to questions of access and reliability. The most important items in this connection are, of course, the main engines and the storage batteries. In each case reliability and long life are in conflict with compactness and light weight. In these important respects, there is as yet no uniformity of practice in the different navies of the world. In certain continental countries, notably Germany, the extreme of lightness and compactness is sought, accessibility is sacrificed, and a very highly trained personnel is relied on for reliability. The wide range of practice is illustrated by the fact that the weight in pounds per horsepower of the main engines of the single-acting Diesel type almost universally used varies from 50 to 100. In the case of storage batteries, the weight per motor horsepower at the one hour rate of discharge varies from 131 to 253 pounds. The smaller figure represents the extreme case where the durability of the battery is sacrificed to capacity. The heavier of the two batteries is, in fact, expected to have a service life at least three times as great as the lighter.

Quite aside from the type of machinery adopted, the matter of access and roominess in general is of great importance, and finally we must in addition consider the demands made by safety features, including elaborate bulkhead sub-division, as well as the installation of special fittings and appliances, such as submarine signals and the like.

To illustrate the aggregate effect of such considerations, we may compare a comparatively simple design of date of 1910 with a very recent one. The early design has the following characteristics:

1910
 Surface speed.....14 knots
 Surface fuel radius.....2,490 miles
 Submerged speed.....11½ knots
 Submerged radius at 5 knots.....110 miles
 Armaments.....4 torpedo tubes and 4 torpedoes

LATER DESIGN

Surface speed.....14 knots
 Surface fuel radius.....3,150 miles
 Submerged speed.....10½ knots
 Submerged radius at 5 knots.....75 miles
 Armaments.....4 tubes, 8 torpedoes and one 3-inch gun

It will be noted that the newer design provides for slightly greater armament with an increase in the surface radius. On the other hand, this has been compensated for by a decrease in the submerged speed and radius. Notwithstanding this reduction in submerged qualities, the surface displacement is increased sixty percent. In this particular case, there is no material difference in the weight and space per horsepower of the main engines and the very large increase in displacement has nearly all been absorbed by habitability and safety features.

In addition to the engineering problems involved, the development of the submarine is discussed at length from a military standpoint and the probabilities are considered with respect to the characteristics of the United States submarines of the near future, both for coast defense and for fleet service.

New Marine Refrigerating Machine

Description of Construction and Operation of Westinghouse-Leblanc Refrigerating Machine Designed for Marine Work

BY G. L. KOTHNY*

On Friday, October 29, a public demonstration of a new type of refrigerating machine especially suitable for marine installations was given at the Westinghouse Machine Company's works at East Pittsburgh, Pa., in the presence of some prominent naval men and shipbuilders.

The machine tested is known as the Westinghouse-Le-

water at the desired brine temperature, in an evaporator through which the brine circulates. In other words, if, for instance, it is desired to produce brine at 14 degrees F. temperature, a vacuum corresponding to the vapor tension of water at 14 degrees F. (which is 0.08 inch Hg. absolute), or of 29.92-inch Hg. with 30-inch barometer, has

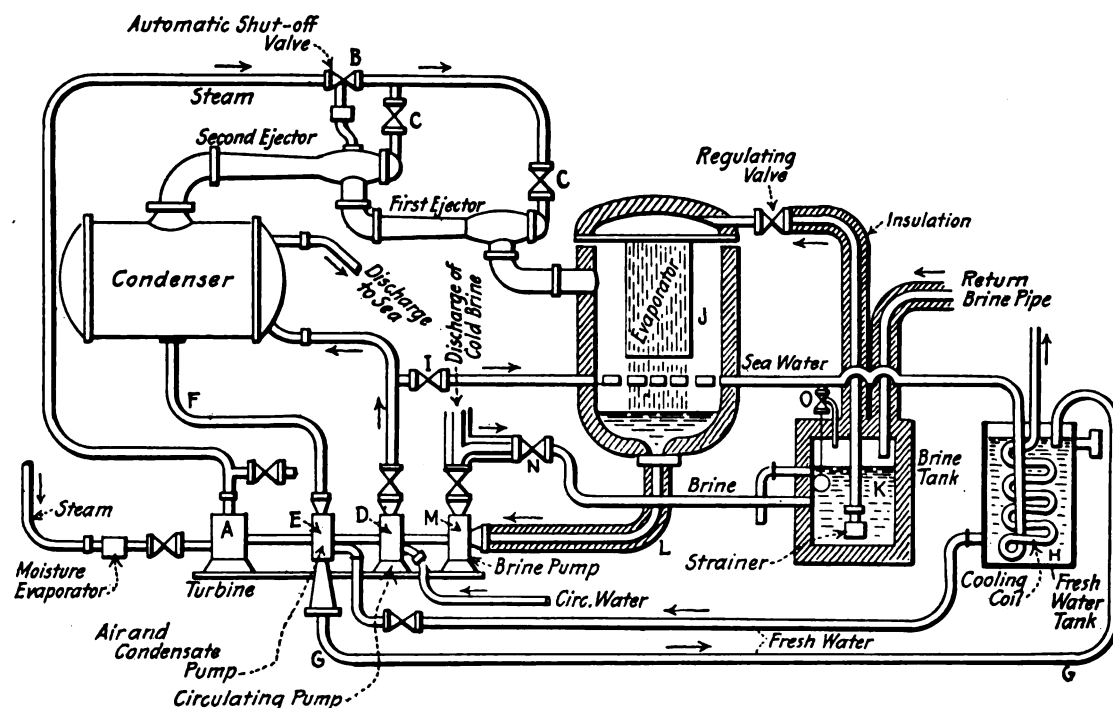


Fig. 1.—Diagrammatic Arrangement of Westinghouse-Leblanc Refrigerating Machine

blanc refrigerating machine, which uses water as a cooling medium and produces cold by direct partial evaporation of water from the brine passing through the machine, and thus cooling the same. Water has always been known as an ideal cooling medium. It is universally available, it is neither difficult nor dangerous to handle, and the ratio between its latent heat and the heat of the liquid is, as shown in Table 1, much higher than that of any other cooling medium.

TABLE NO. 1.—LATENT AND SENSIBLE HEAT OF ONE POUND OF DIFFERENT LIQUIDS FOR 14 DEG. F. LIQUID TEMPERATURE AND 68 DEG. F. CONDENSER TEMPERATURE

	Ammonia NH ₃	Carbon Dioxide CO ₂	Sulphur Dioxide SO ₂	Water H ₂ O
Pressure in brine cooler, lbs. per sq. in.	41.5	385.0	14.6	0.0398
Condenser pressure, lbs. per sq. in.	125.0	825.0	76.0	0.3270
Latent heat, in B. T. U. Heat of liquid, in B. T. U.	558.0	111.0	172.0	1050.0000
Heat units available for producing cold, per lb. Percent, taking water as a base	51.0	32.0	17.4	54.0000
	507.0	79.0	155.6	996.0000
	51.0	7.9	15.7	100.0000

The evaporation of water in the Westinghouse-Leblanc machine is obtained by producing and maintaining a vacuum, which corresponds to the vapor tension of the

to be produced and maintained in the evaporator, the vessel through which the brine circulates and in which it is cooled.

In the Westinghouse-Leblanc machine this is accomplished by a combination of steam ejector or ejectors and condensing plant, the ejector or ejectors producing the difference in vacuum between that necessary in the evaporator and the highest possible vacuum which may be ob-

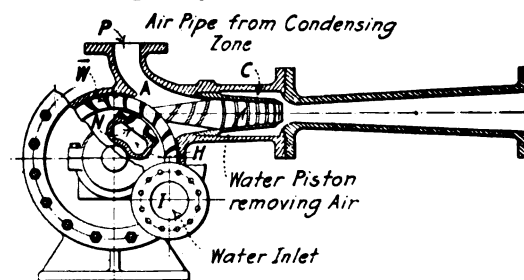


Fig. 2.—Section of Westinghouse-Leblanc Air Pump

tained in the condenser with circulating water of a certain given temperature. A diagrammatic arrangement is shown in Fig. 1. The operation is as follows:

Live steam enters the steam turbine (A) after passing

* Engineer, the Westinghouse Machine Company, East Pittsburgh, Pa.

through a moisture evaporator with a steam pressure of about 200 pounds gage, and develops the necessary energy in the turbine for driving the pumps, which are coupled directly to the turbine. The steam leaves the turbine with a back pressure of about 55 pounds and passes through the automatic shut-off valve *B* and the steam globe valves *C-C* to the steam ejectors (marked first and second ejector). The object of the automatic shut-off valve is to prevent

steam used in the first ejector to the absolute pressure obtained in the surface condenser, thereby delivering those to the condenser, wherein vapors and steam are condensed and removed by the Leblanc air pump *E*.

The ejectors are of convergent divergent shape and have multiple steam nozzles, which are arranged in ranges, the outer ones overlapping the inner ones. Fig. 3 shows a sectional view of one of the ejectors, and Fig. 4 shows

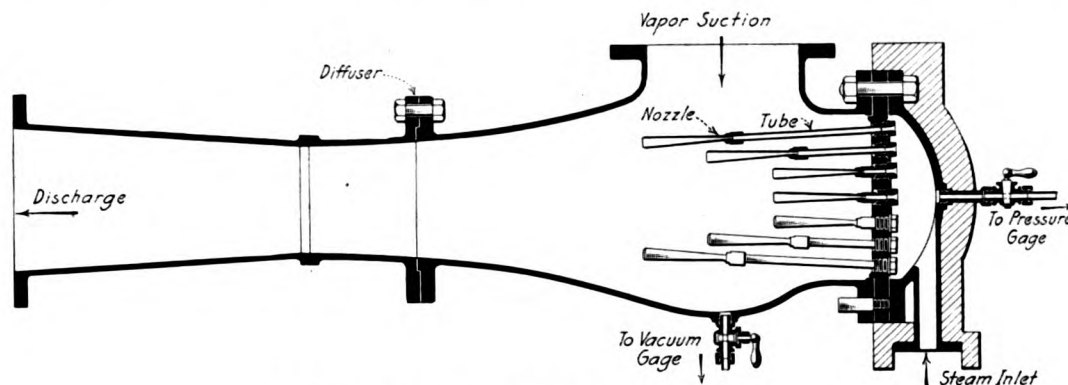


Fig. 3.—Section of Westinghouse-Leblanc Steam Ejector

steam from entering the ejectors as long as there is no vacuum in the evaporator or condenser. The valve itself is controlled by vacuum and will not operate unless a designed vacuum exists in the condenser.

The high vacuum in the evaporator is produced and maintained by the two steam ejectors, working in conjunction with a surface condensing plant. The surface condensing plant consists of a surface condenser, condenser circulating pump (*D*) and Leblanc air and condensate pump (*E*). Circulating water enters the circulating pump, passes through the pump, which is of the centrifugal type and also through a non-return valve, then through a pipe as indicated by the arrows into the condenser, and is finally discharged back to the sea. The air and condensed steam are taken out from the condenser through pipe *F* and removed by the air pump *E*, which is of the rotary hydraulic type, through pipe *G* into the fresh-water tank *H*.

A cross-sectional view of the Westinghouse-Leblanc air pump is shown in Fig. 2. The principle of operation is illustrated in this figure. Water enters the chamber *H* through the opening *I* and flows out through the orifice *N*. The impeller *W*, rotating in a clockwise direction, cuts off layers of water and projects them into the cone *C*. Between the successive pistons of water, layers of air drawn in through opening *P* are imprisoned. The high velocity of these water pistons is transformed into pressure by means of the diffusing cone so the moisture may be discharged against atmospheric or somewhat higher pressure.

It is obvious that the temperature of water in tank *H* (Fig. 1) would gradually increase, due to the continual addition of the heat contained in the condensed steam. As it is essential that cold water should be used in the air pump, a cooling coil is placed in the air pump water tank and a portion of the discharge from the circulating pump *D* regulated by valve *I* is passed through the coil.

The ejectors are operated by the exhaust steam of the turbine and are arranged in series. The first ejector removes the vapors from the evaporator *J*, thereby maintaining inside of the evaporator an absolute pressure corresponding to the vapor tension of the brine temperature and compresses the same to a higher absolute pressure, which is produced and maintained by the second ejector. The second ejector compresses the vapors plus the live

a typical photograph of the arrangement of the steam nozzles.

The circulation of the brine is as follows: By the high vacuum existing in the evaporator *J*, brine is drawn into the evaporator from the brine tank *K*, passing through a strainer in the bottom of the tank and then through the vertical pipe and through a regulating valve before entering the top of the evaporator. Inside the evaporator a section through which is shown in Fig. 5, it is distributed through small orifices and falls down in the form of a fine spray or rain. While falling down, a part of this

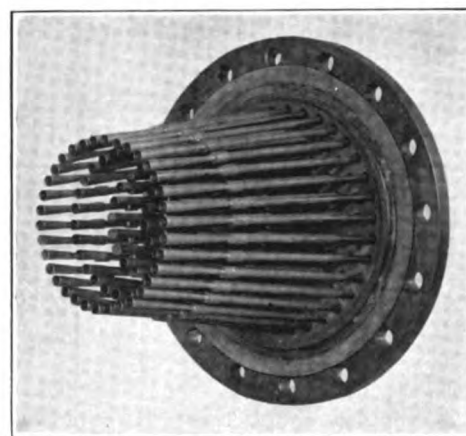


Fig. 4.—Ejector Nozzles

brine is evaporated and the remaining brine is cooled down and taken out through pipe *L* by the brine pump *M*. After leaving the pump it passes through a non-return valve and into the pipe which carries the cold brine to the place where it is to be used—that is, either to the ice-making tank or cold storage rooms. Thence the brine returns to the brine tank *K* through the return pipe and is recirculated as already described.

An automatic brine pressure relief valve *N* is provided at the discharge of the brine pump and the outlet of this valve is connected directly to the brine tank *K*. The object of this valve is to allow the brine to return automatically to the brine tank in case all the valves in the

brine system (which may be located far away from the machine) are accidentally closed and thus prevent the discharge of brine from the pump, which would result in the filling up of the evaporator. Fig. 6 shows a section through this valve which may be adjusted to operate at any specified pressure.

A certain amount of water corresponding to the B. T. U.'s output of the machine is evaporated while the brine passes through the evaporator, and this has to be added again to prevent the brine from becoming more and more dense. This is automatically done by the make-up valve *O*, which opens whenever the brine level in the

Fig. 8 shows a section through the surface condenser. The condenser is of the four-pass type and has $\frac{5}{8}$ inch O. D. tubes, No. 18 B. W. G.; the air suction is arranged on the side of the condenser, while the condensate outlet is located at the bottom.

Fig. 9 shows the arrangement and also illustrates the operation of the automatic shut-off valve *B* (Fig. 1). A flexible diaphragm reinforced by a steel plate and held upwards by a spring forms the top cover of a small cylinder which is connected to the surface condenser. When the vacuum reaches a certain point, the atmospheric pressure will overcome the compression of the spring and move

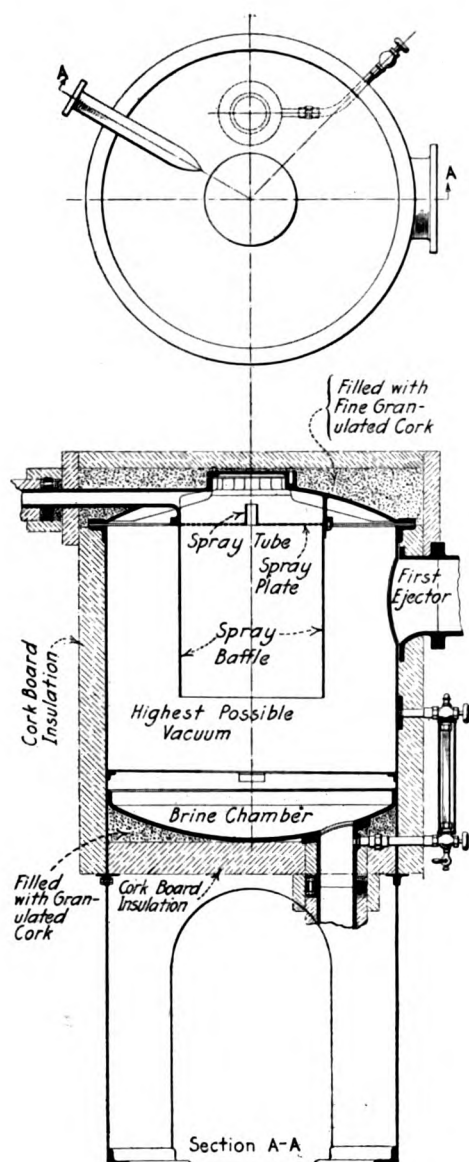


Fig. 5.—Evaporator

brine tank lowers and allows some sea water to flow into the brine tank until the normal brine level is reached.

A section through the driving steam turbine, the circulating, air and brine pumps is shown in Fig. 7. The turbine is of the single-wheel impulse type and has an automatic stop governor which prevents the turbine and pumps from running at an undesirable speed. As all of the pumps are of the centrifugal type, and two of them are always submerged, there is no necessity to provide a speed regulating governor. All the pumps have automatically water or brine sealed glands which insure their being air tight.

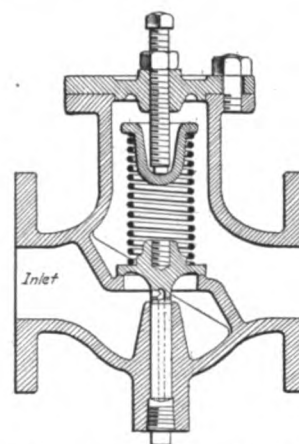


Fig. 6.—Section of Brine Relief Valve

the trip rod downwards. If the trigger operating the steam valve is now pressed down, the catcher on the trigger will be caught by the trip rod and the valve will be held open. As soon as the vacuum drops to a point where the atmospheric pressure does not any more overcome the compression of the spring underneath the diaphragm, the trip rod will be lifted and the trigger will be released, thereby closing the steam valve.

An outline of the complete machine as described is shown in Fig. 10, while Fig. 11 shows a photograph of the same machine. Referring to Fig. 11, the pumps and their driving turbine will be seen at the bottom of the picture, the circulating pump being at the extreme left, followed by the steam turbine, which is lagged and covered; next to it is the Leblanc air pump, on top of which the air and condensate suction pipe is seen, and finally on the extreme right is the brine pump, which is insulated with cork.

The machine demonstrated was used for making ice and the cold brine discharge was connected to an ice-making tank (Fig. 12) of a design suitable for marine service. The tank holds 9 U. S. Standard ice cans. Each can has a steel brace riveted around the top, which also holds a rubber packing where this brace comes into contact with the cover plate of the tank. The ice cans are held down to the cast iron cover plate by semi-circular wedges, which are operated by a spanner or wrench. The cans are thus held tight against the tank, which prevents any splashing of brine when the ship is rolling. The brine surrounding the cans inside of the tank is cooled and kept at an equal temperature by a rectangular cooling coil located inside the tank close to its outer walls through which the cold brine discharged from the refrigerating machine passes. The ice cans are covered with wooden lids, which prevent any splashing of fresh water when the cans are filled up at the beginning of the process of freezing. The circulating brine inlet and outlet will be seen on the right-hand side.

A capacity test of this machine was made previous to

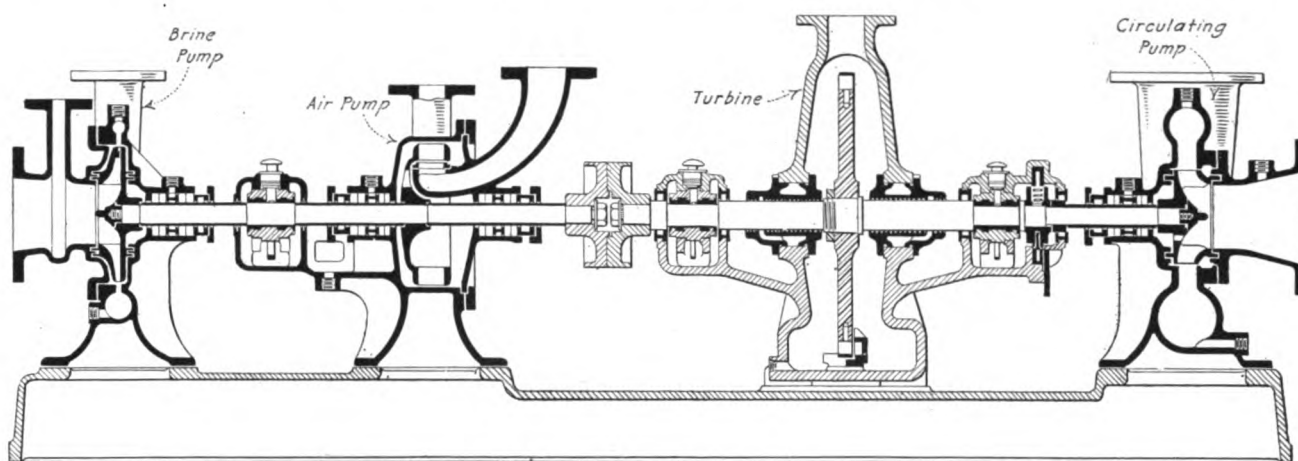


Fig. 7.—Section Through Turbine, Brine, Air and Circulating Pumps

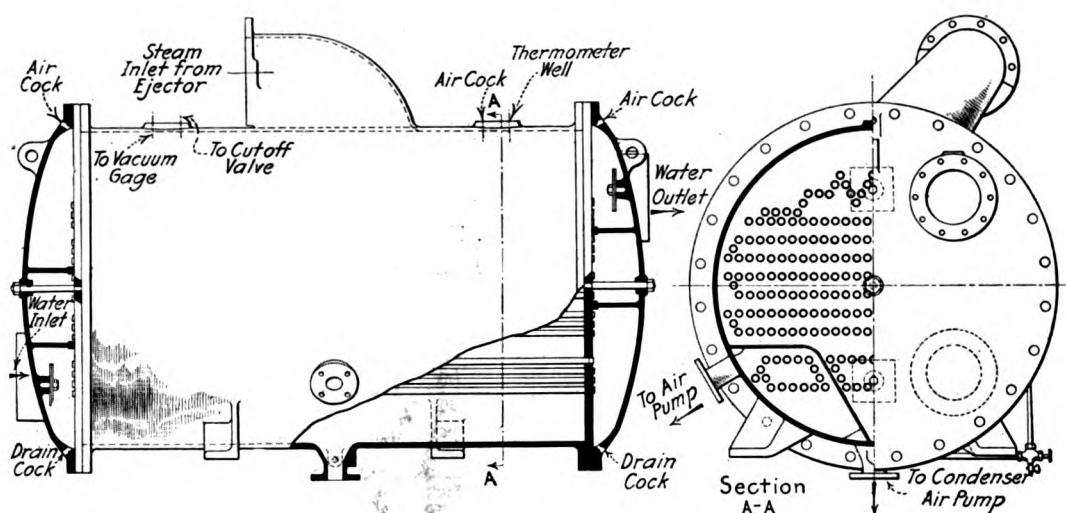


Fig. 8.—Condenser

the demonstrating test. In carrying out this test, the machine was used for making ice in the marine type ice

tank, but as the cold required by this tank was less than that produced by the machine, a heating device for heating up the brine was arranged in order to dissipate the total cold produced by the machine. The machine was designed for three tons of refrigeration per day for the following working conditions: Maximum temperature circulating water inlet, 85 degrees F.; brine temperature at discharge of brine pump, 10 degrees F.; live steam pressure, 200 pounds gage; total steam consumption, 955 pounds.

The results obtained with the different brine temperatures are given in Table No. 2. All of the figures represent at least ten independent readings, during which the temperature of the brine at the discharge was maintained practically constant. Referring to this table, it will be noted that the capacity of the machine increases considerably with the increase of the brine temperature. For instance, with a brine temperature of 30 degrees at the discharge the capacity is 8.6 tons of refrigeration. With 10 degrees at the discharge, the capacity is 4.5 tons of refrigeration per day, which is about 50 percent in excess of the designed capacity, which may be considered as a very satisfactory performance.

For higher brine temperatures it will not be necessary to use two ejectors in series. One ejector will do the compression work and naturally the steam consumption of this ejector will become considerably less than that of two ejectors. The pumps may also be motor driven if more convenient.

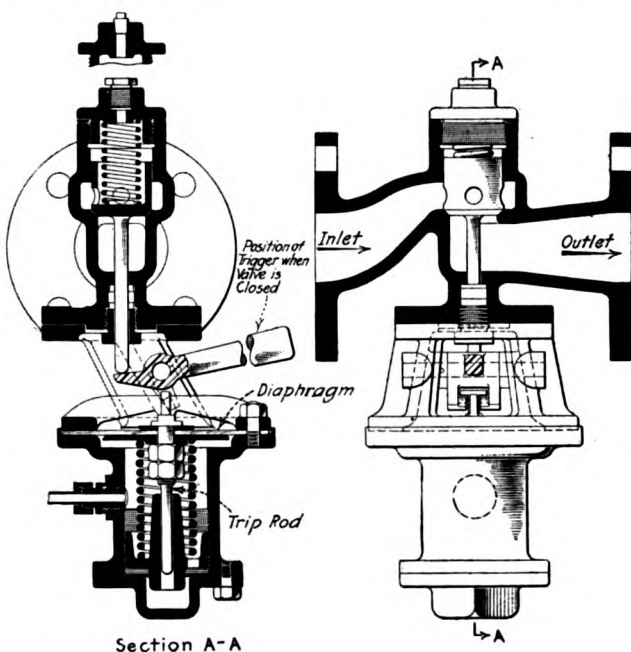


Fig. 9.—Sections Through Automatic Steam Shut-Off Valve

The advantages of this refrigerating machine may be summarized as follows:

The Complete Absence of Chemicals or Compressed Gases.—This is considered of great importance for navy work, as it makes ships using this type of machine naturally independent of the supply of chemicals. They do not need to carry a supply of flasks containing gases at a high pressure, which are a source of danger to the vessel itself, nor will the lack of chemicals interfere with the refrigeration. They can produce refrigeration as long as there is coal available on board to make steam. For a warship this is a most important consideration. In times of war it might be impossible for the vessel to obtain a supply of chemicals, making it necessary to discontinue refrigeration, thereby spoiling the foodstuff in tropical or semi-tropical climates. The powder and ammunition maga-

zines may also be endangered, as some powders or explosives, unless properly cooled, deteriorate and explode from self-combustion. Furthermore, flasks containing gas under pressures of 600 to 1,000 pounds per square inch, if struck by one of the enemy's projectiles, would cause as much damage to the ship as the explosion of the projectile

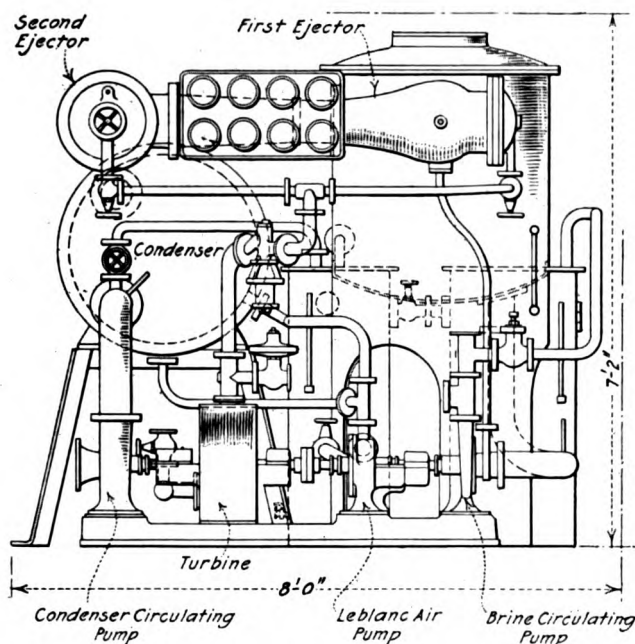
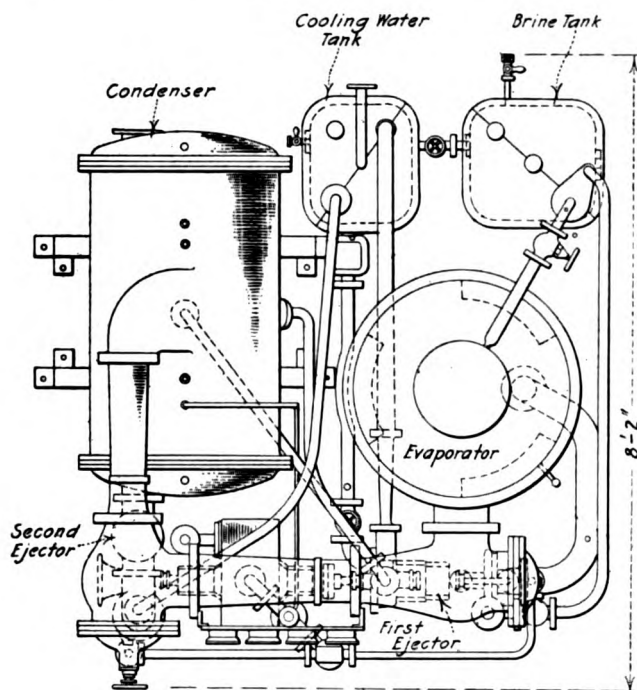


Fig. 10.—Outline of Refrigerating Machine, Showing Plan and Front and Side Elevations

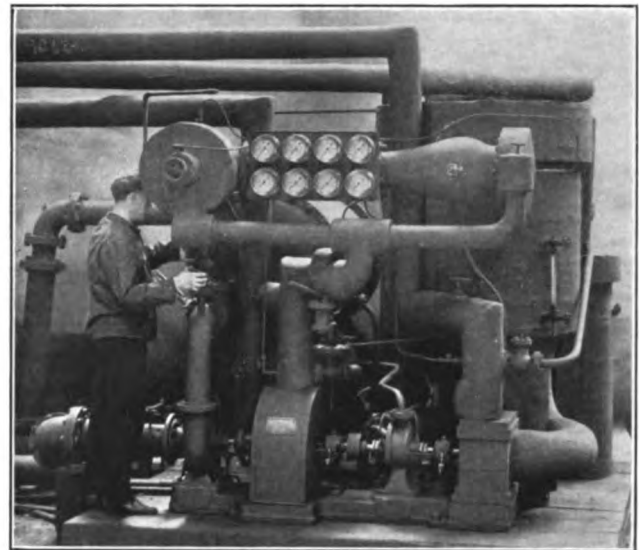
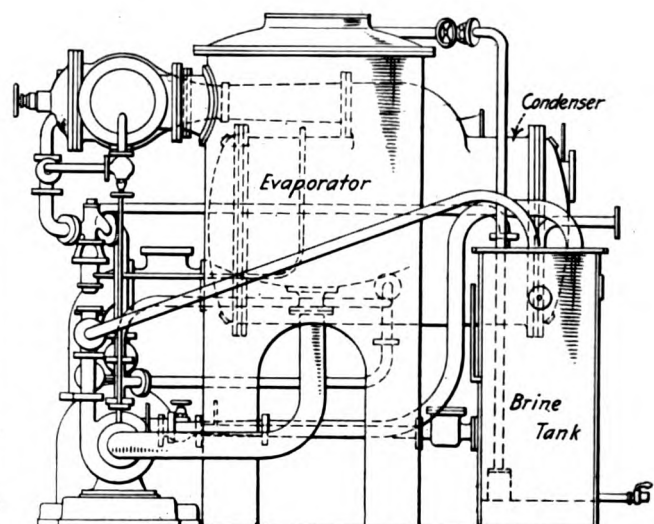


Fig. 11.—Refrigerating Machine Under Test at Westinghouse Works



Fig. 12.—Marine Type Ice-Making Tank



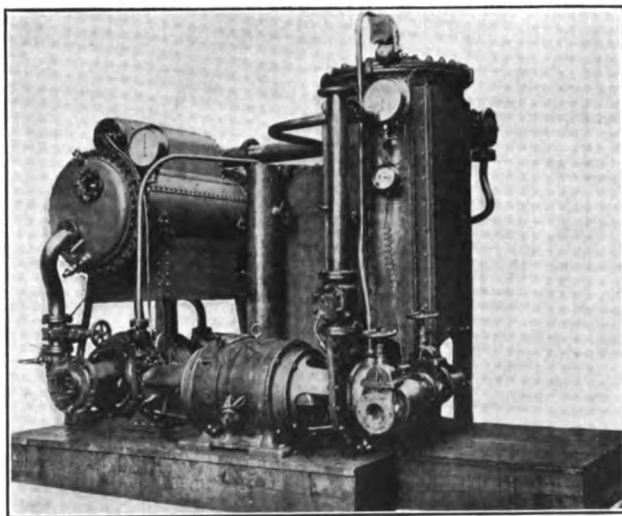


Fig. 13.—Motor-Driven Refrigerating Machine Used in the French Navy

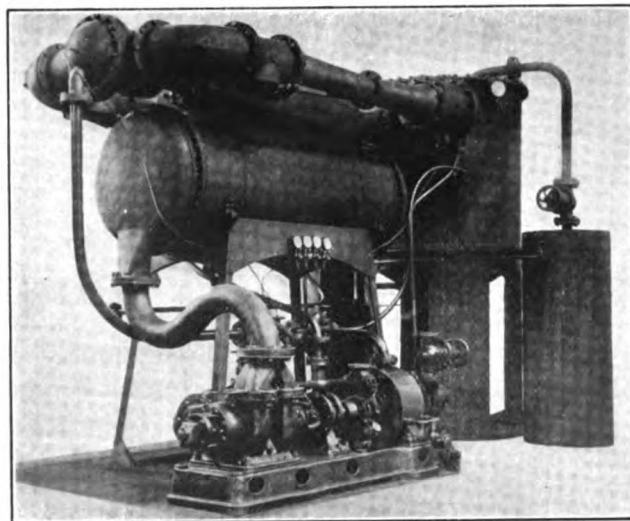


Fig. 14.—Turbine-Driven Refrigerating Machine on Board S. S. André Lebon

itself. In the machine described above no gases are used and no pressures have to be maintained. The highest pressure is atmospheric pressure and the cooling medium used are water vapors.

Minimum Weight and Space Occupied.—This is mostly due to the absence of high-pressures inside the machine and also to the direct cooling of the brine. The construction can be very light and at the same time rigid enough to stand atmospheric pressure. It is claimed that the weight of this machine and the space occupied by it are only one-third or one-half that of other types.

Simple Operation.—All of the pumps are of the centrifugal pump type, and form a single revolving element without close clearances. There are no valves to be kept tight, no piston rods to pack and no parts to adjust. The operation is practically automatic and requires no specially trained engineers. The running is silent, a point of particular importance where the apparatus is used on passenger steamers.

Low Cost of Operation and Maintenance.—The reason for this is obvious, when the simplicity of the apparatus is considered. Practically no repairs are needed, there are no chemicals and no high-pressures to handle.

Efficiency.—Tests have shown that the results compare very favorably with those of other types, especially when

the inlet temperature of the circulating water is around 85 degrees F.

Brine Coolers Eliminated.—Most of the other types of machines use a brine cooler, which forms a considerable item in weight and space on board the ship. In this machine the brine is cooled directly in the evaporator, and therefore does not require any separate brine cooler.

These many advantages have induced the navies and many of the steamship companies of France, Russia, Austria, Germany, England, Japan, Spain, Greece and Argentina to use this machine on their vessels for ice making, cold storage and magazine cooling. Up to June, 1914, about 250 machines had been installed and ordered in these different countries for marine work, some of them having been in service for over three years, giving excellent results without interruption in service or ever being subjected to any repairs.

A photograph of the type of machine used in the French Navy is shown in Fig. 13. The machine illustrated is of 8 tons refrigeration capacity and is motor driven. Fig. 14 shows a 10-ton turbine-driven machine. Several of these have been installed on the following steamers: *André Lebon*, *Athos*, *Porthos*, *Sphinx* of the Compagnie des Messageries Maritimes, Marseilles, France. These steamers ply between Marseilles, France, and Yokohama, Japan,

TABLE NO. 2.—TEST RESULTS (WESTINGHOUSE-LEBLANC) OF NAVY TYPE REFRIGERATING MACHINE. TESTED AUG. 4 AND 5, 1915. LIVE STEAM, 200 LBS./IN². BAROMETER 29.17 INS. HG. TEMP. OF ATMOSPHERE, 85° TO 87° F.

VACUUM, INCHES OF MERCURY.			CIRCULATING WATER TEMPERATURE.		BRINE.						REFRIGERATION.				STEAM CONSUMPTION.		
1st Ejector.	2nd Ejector.	Con- denser.	Inlet to Con- denser.	Within Fresh- Water Tank.	Temperature.			QUANTITY.			B.t.u. Per Hour.	Tons Per Day.	Loss Through Frosted Surface Tons Per Day.	Total Tons.	Steam and Vapor Per Hour.	Vapor Per Hour.	Total Steam Consumed by Turbine and Ejectors.
					Inlet.	Dis- charge.	Differ- ence.	Pounds Per Hour.	Density Salo- meter.	Spec. Heat.							
28.95	28.95	27.35	86.	95	35.50	30.05	5.45	19,080	76	.834	99,598	8.30	0.32	8.62	1,276	106	1,170
28.95	28.95	27.35	85.5	94	27.00	22.80	4.20	19,080	80	.829	76,702	6.39	0.35	6.74	1,276	82	1,194
29.00	28.95	27.80	82.5	92	18.40	15.00	3.40	17,240	77	.833	56,202	4.68	0.37	5.05	1,125	61	1,064
29.00	28.95	27.80	83.0	92	13.00	10.00	3.00	17,240	80	.829	49,479	4.13	0.42	4.55	1,102	53	1,049
29.00	28.95	27.60	86.0	94	13.15	10.10	3.05	17,240	80	.829	50,341	4.20	0.42	4.62	1,042	54	988
29.00	28.95	27.60	84.0	93	11.85	8.90	2.95	16,800	80	.829	47,544	3.96	0.45	4.41	975	52	923
29.00	28.95	27.60	84.5	94	12.80	9.80	3.00	17,240	80	.829	49,479	4.13	0.42	4.55	1,013	53	960

The loss of refrigeration through frosted surfaces is based on 21 ft.³ actually measured. taken at intervals of 10 minutes.

Above readings are the averages of 10 independent readings for each temperature range.

passing through the Red Sea, the Indian Ocean and the South China Sea. In those waters the temperature of the circulating water often reaches 90 degrees F., and in spite of this severe condition the machines installed have successfully met all specifications under test.

The Westinghouse Machine Company, of East Pittsburgh, Pa., who are the sole licensees of the Leblanc patents in the United States, have recently taken up the manufacture of this machine for marine as well as for land installations.

New Vacuum Apparatus

Westinghouse-Leblanc Air-Ejector System for Producing High Vacuum

BY G. L. KOTHNY*

On the occasion of the demonstration of tests of a new type of refrigerating machine at the Westinghouse Machine Company's works at East Pittsburgh, Pa., which is described on another page in this issue, a new high-vacuum producing device was also shown to the visitors.

This device is called the Westinghouse-Leblanc air-ejector system. It is a substitute for the ordinary reciprocating vacuum pump, or any other vacuum pump of hydraulic or

the condensate pump and discharged into an air-separating tank, where the steam and vapor coming from the air ejector are condensed by the condensate discharged from the condensate pump. The temperature of the condensate is naturally increased by the heat given to it from the steam discharged from the air ejector. The non-condensable gases and the air removed from the condenser are separated in this tank and escape to the atmosphere

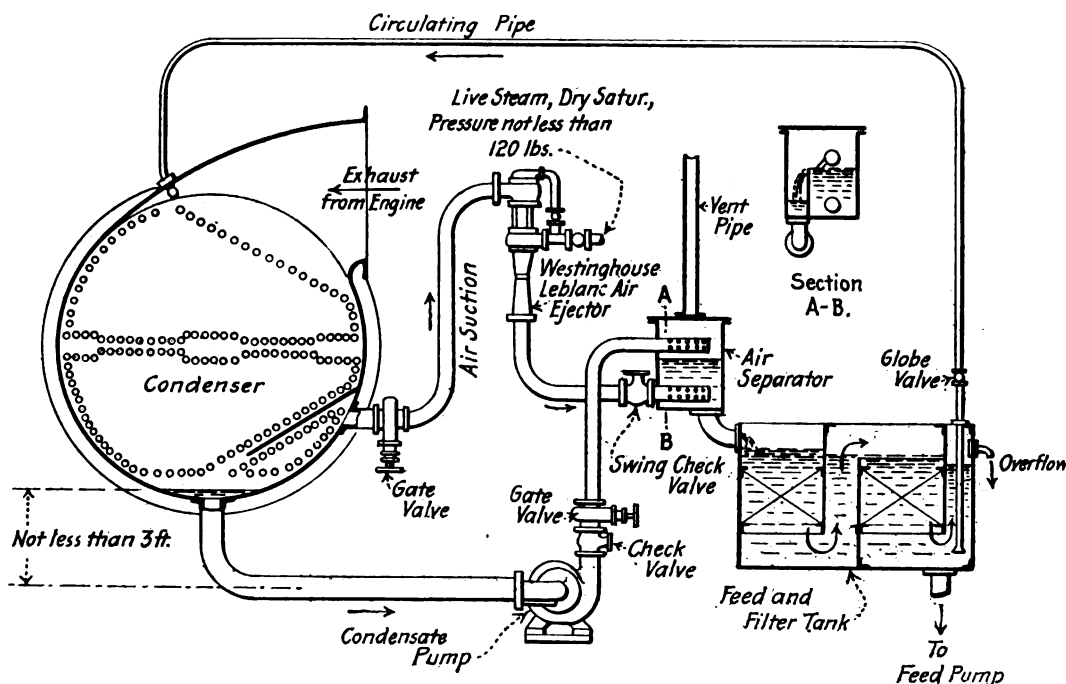


Fig. 1.—Diagrammatic Arrangement of Westinghouse-Leblanc Air Ejector System

rotary-piston type, and is designed to produce a very high vacuum in the condenser. The air and non-condensable gases are taken out of the condenser by an air ejector of special design operated by live steam, and the condensed steam is removed from the condenser by a turbine-driven condensate pump of the centrifugal type. A diagrammatic arrangement of this Westinghouse-Leblanc air-ejector system is shown in Fig. 1.

Referring to this figure, the operation is as follows: Live steam of any pressure available from the boilers enters the ejector, which acts as a dry vacuum pump, and withdraws the air from the condenser, thereby creating a high vacuum in the same. The condensate, which collects at the bottom of the main condenser, is taken out by

through a vent pipe which is arranged on top of the tank. The condensate flows by gravity to the feed and filter tank, from which it is taken by the boiler feed pumps into the boilers. As will easily be seen, the apparatus has the highest thermal efficiency possible, as all the heat supplied is regained in the feed water.

The condensate pump is of the centrifugal type and of special design to operate with a low submergency on the suction side, in order to avoid a high location of the condenser. It is driven by a small steam turbine, the shaft of the turbine being extended to bear the impeller of the pump, which has a single inlet, thus requiring only one gland. This gland is automatically water sealed, thus insuring air tightness. Fig. 2 shows such a pump, having a capacity of 130,000 pounds of steam per hour when

* Engineer, the Westinghouse Machine Company, East Pittsburgh, Pa.

working with 12-inch submergency against a total head of 65 feet. It will be noted that the size of the pump is very small, considering its working conditions. The weight of the complete pump, turbine and bed-plate is 750 pounds.

The air ejector is shown in Fig. 3, and a section and

The purpose of this pipe is explained by the following: It might occur sometimes that the main engines are stopped and that very little steam is entering the main condenser from the auxiliaries, so that there is a very small quantity of condensate to be removed from the con-

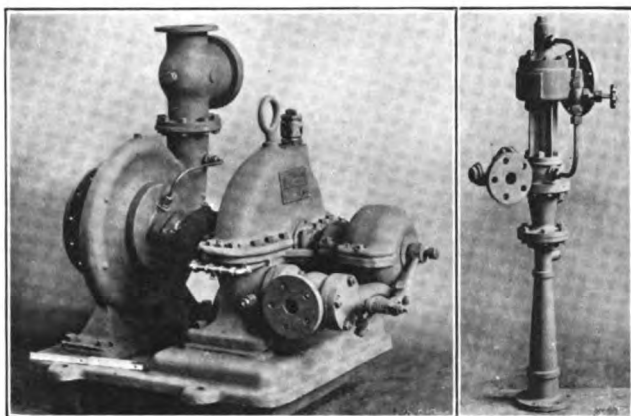


Fig. 2.—Condensate Pump

Fig. 3.—Air Ejector

further details of this are given on page 551. Two ejectors as illustrated are sufficient for a condensing plant condensing 100,000 pounds of steam per hour, when maintaining a vacuum of $28\frac{1}{2}$ inches with 60 degrees of circulating water. The length of the ejector shown is 3 feet and its weight is 97 pounds.

Referring back to Fig. 1, a circulating pipe will be seen connecting the main condenser with the feed-water tank.

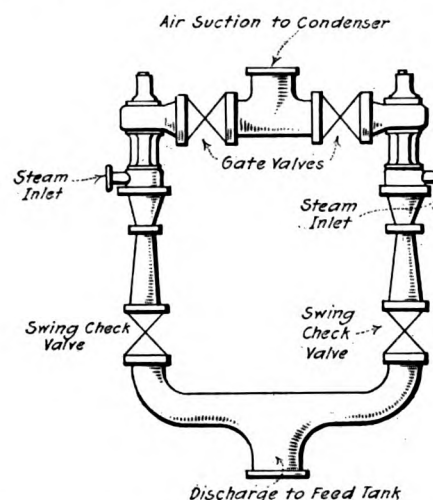


Fig. 4.—Arrangement of Two Air Ejectors in Parallel

denser. If at the same time the vacuum is to be maintained in the condenser the steam coming from the air ejector would have very little water to be condensed with and the continuous adding of heat by the steam from the ejector may heat up the feed water to an undesirably high temperature. To avoid this and to enable a desired tem-

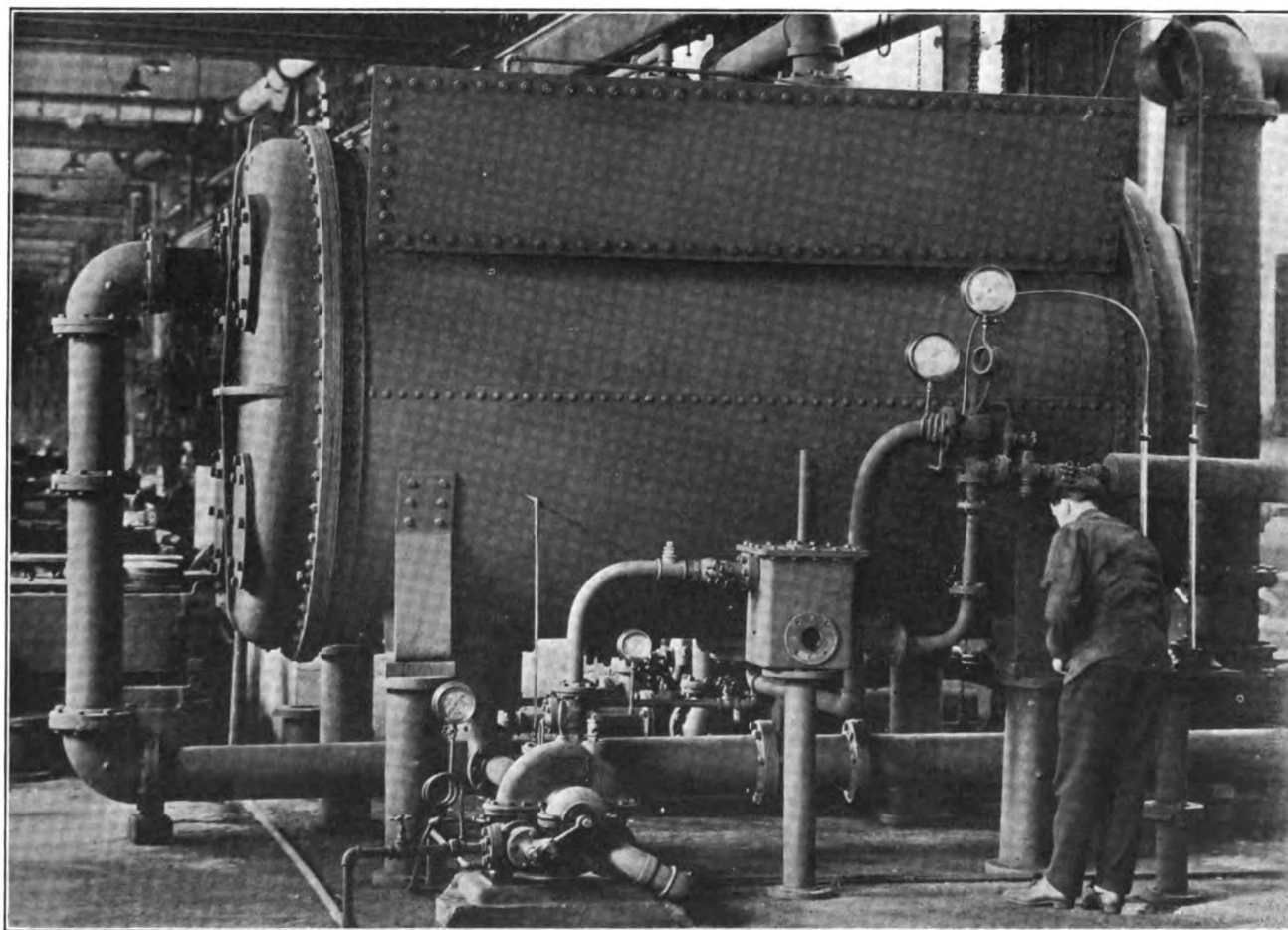


Fig. 5.—Air Ejector Installation at the Westinghouse Machine Company's Works

perature to be maintained in the feed tank, the circulating pipe is provided.

By opening the valve shown in this pipe, hot water from the feed tank is sucked into the condenser by the vacuum, and, while falling over the cold condenser tubes, it is cooled. The cooled water is taken out by the condensate pump and discharged into the air separating tank, where it condenses the steam coming from the air ejector and from where it flows to the feed tank. Part of this water is returned to the condenser and recirculated as described. By regulating the quantity of water returned to the condenser, the temperature of the feed water in the feed tank may be regulated. If, however, a number of auxiliaries are operated while the main engine is idle, the exhaust from the auxiliaries may enter the main condenser and sufficient water will be taken out by the condensate pump for condensing the steam coming from the air ejectors.

Instead of using one ejector, two or three of a smaller size may be arranged in parallel for one condenser, thus allowing one or two ejectors to be shut down (thereby saving one-half or one-third of the steam consumption) when running at low speed or during the cold season, when the vacuum is higher on account of the low temperature of the circulating water. Fig. 4 shows a diagrammatic arrangement of two ejectors in parallel. Gate valves have to be provided at the air suction. The gate valve on the ejector which is not in operation should be closed in order to prevent the atmospheric air from passing through this ejector back into the condenser.

Fig. 5 shows an air-ejector installation at the Westinghouse Machine Company's works at East Pittsburgh, Pa. At the bottom of this picture and to the extreme left the turbine-driven condensate pump is shown. Next to it is the air-separating tank, and at the right-hand side the air ejector.

An installation of this kind has also been made on the United States torpedo boat tender *Melville*, built by the New York Shipbuilding Company, Camden, N. J. The air-ejector system was installed in parallel with the already existing reciprocating air pump and vacuum augmentor, in order to enable a true comparison of both systems under absolutely identical conditions. The performance of the air-ejector system on the *Melville* has been very successful; the vacuum obtained was higher, with less steam consumption than that obtained by the augmentor. A higher feed-water temperature was also obtained and the weight and space occupied by it are considerably less than that of the augmentor system.

The advantages of this new device may be summarized as follows:

Minimum Weight.—A few figures will illustrate this. Taking for example the installation of the main air pump for one main condenser on a battleship: The size of such a pump is 18 inches by 36 inches by 36 inches by 27 inches; its weight about 15,000 pounds. To this would have to be added the weight of the augmentor, the augmentor condenser, the water seal and the inter-connecting piping between the different parts of the augmentor installation, which is about 5,500 pounds, the total weight of one complete air pump installation with augmentor being 20,500 pounds without water.

The Westinghouse-Leblanc air-ejector installation would weigh as follows:

Air ejectors	650 pounds
Condensate pump, turbine and bed-plate....	1,000 "
Valves, accessories and air-separating tank.	920 "

Total weight of installation..... 2,570 pounds
against 20,500 pounds of the reciprocating-pump installation, or the air-ejector installation weighs only about one-

eighth of the reciprocating-pump installation. This does not include the difference in weight of the piping, the sizes of which are considerably larger for the reciprocating-pump installation, and when filled with water will be considerably greater in weight.

Minimum Space.—The space occupied by the Leblanc air-ejector system is from one-eighth to one-tenth that of the reciprocating-pump installation. Furthermore, the air ejector has the advantage that it may be located anywhere, just like a piece of pipe, and also does not need to be in a certain relative position to the main condenser or to the condensate pump. The reciprocating pump and the vacuum augmentor, augmentor condenser and water seal, however, must always be arranged in a relative position to each other, which makes the general arrangement of the augmentor installation difficult and complicated.

High Thermal Efficiency.—All steam used in the air ejector and the turbine driving the condensate pump is condensed by the condensed steam from the main condenser. The temperature of the condensate is raised by the heat contained in the steam of the air ejectors and the turbine, while in the augmentor system the heat contained in the steam operating the augmentor is thrown overboard as it is transmitted to the circulating water passing through the augmentor condenser.

Simplicity.—The Leblanc air ejector is a static apparatus, and therefore does not require any attention during its operation. The condensate pump is of the centrifugal type without close clearances or valves to look after, and all that needs attention is the turbine bearings, since they should be supplied with sufficient lubricating oil. However, if there is a feed-oil system on board the ship, it may be used for supplying oil to these bearings, and then the condensate pump will not require any attention.

Maintenance.—The complete absence of internal rubbing parts, of reciprocating valves, etc., eliminates the wear and tear, and no repairs are required, which are frequent with pumps of the reciprocating type.

Small Steam Consumption.—The steam consumption of the air-ejector system is less than that of a reciprocating pump working in conjunction with a vacuum augmentor, when working under similar conditions.

The Westinghouse Machine Company, of East Pittsburgh, Pa., the sole licensee for all Leblanc patents relating to condensing apparatus, is now manufacturing this air ejector for marine condenser installations.

MONTHLY SHIPBUILDING REPORT.—The Bureau of Navigation, Department of Commerce, reports 88 sailing, steam, gas and unrigged vessels of 17,368 gross tons built in the United States and officially numbered during the month of October. Seven steel steamships, aggregating 9,866 gross tons, were built during the month, the largest being the *Plymouth*, of 5,266 gross tons, built by the New York Shipbuilding Company, Camden, N. J., for the Coastwise Transportation Company, Boston, Mass. From other sources than construction, 8 vessels of 19,467 gross tons were admitted to American registry during the month.

DRY DOCK AT PRINCE RUPERT TESTED.—The official test of the 20,000-ton floating dry-dock at the ship-repair plant at Prince Rupert has been made successfully and the plant is now ready for work. This plant, which includes, in addition to the dry-dock, a carpenter shop, shipbuilding shed and launching platform, machine shop, boiler and blacksmith shops and foundry and a power plant, was built by the Grand Trunk Pacific Railway in accordance with designs by Mr. William T. Donnelly, consulting engineer, New York.

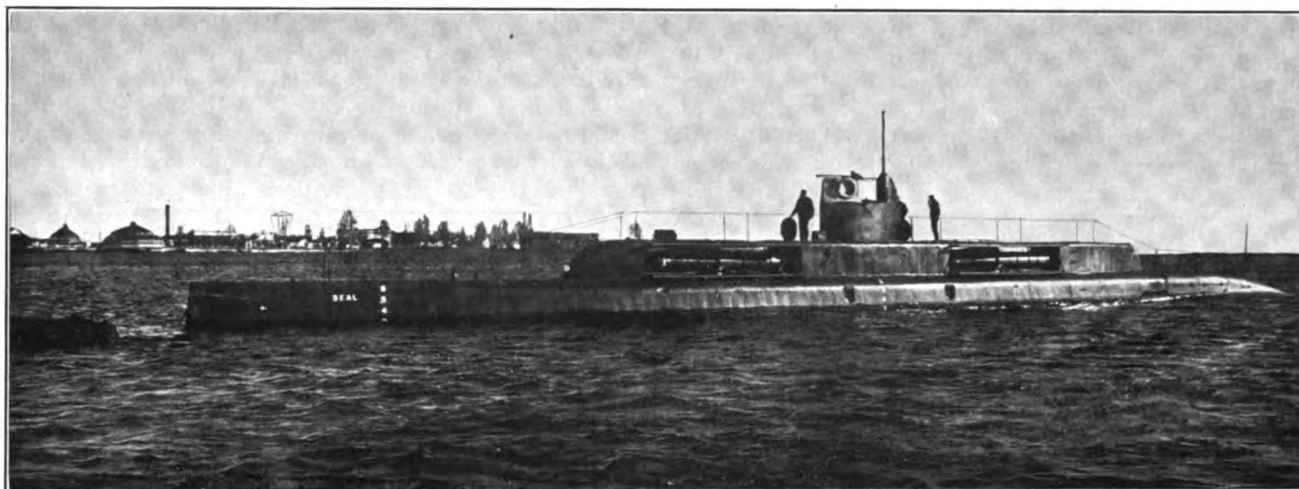


Fig. 46.—The Seal, or G-1

The *Seal* was the first submarine ever built to be fitted with torpedo tubes that could be trained to fire to either broadside. All other United States submarines must maneuver to bring the axes of the ship in line with the target before firing. This maneuvering is very apt to betray the position of the submarine's periscope when moving through the water, as it makes a white "wake" which can readily be seen by the observer on the enemy's vessel. If the periscope is at rest, however, and painted a neutral tint, it is almost impossible to see it even at a distance of three or four hundred yards. The ability to train the torpedo is therefore of importance, for it prevents the likelihood of the submarine's presence being known. The ability to train the torpedo is also of importance in that it permits the submarine to lie in wait for, and then pursue a course parallel to, the enemy's ship at close range. The enemy's ship is therefore within torpedo range a very much longer period of time than she would be if the submarine was forced to make a "head-on attack."

Modern Submarines in War and Peace—VI

Coast Defense and Cruising or "Fleet" Submarines—Value of So-called "Amphibious" Submarines for Defense Purposes

BY SIMON LAKE

Coast defense submarines will probably be found to be the most important adjunct to any navy in every country whose policy is to defend their own coast lines, rather than to become an aggressor. Vessels for this purpose do not need to be of great tonnage, nor of high speed. Speed is the one thing, more than anything else, which runs up the cost of the submarine vessel. While speed is desirable for the cruising submarine, it is not an essential for a defensive submarine. It is possible to get a speed of 14 or 15 knots in a submarine of about 500 tons displacement and at the same time have comfortable living quarters for the crew. A boat of this size may carry eight Whitehead torpedoes, each torpedo being capable of destroying a fifteen-million-dollar battleship, and as a 500-ton displacement submarine can be built for about one-half million dollars, and is capable of carrying eight Whitehead torpedoes, potentially good for eight fifteen-million-dollar battleships, or a total of one hundred and twenty million dollars' worth of capital ships, it seems as if that would be sufficient to ask of one little submarine boat.

Now, to double that speed would require a much larger vessel, and would cost approximately two and one-half million dollars. A two and one-half million dollar boat for the defense of harbor entrances or sea coast cities would not carry as many torpedoes as five of the 500-ton boats. A torpedo fired from a small boat is fully as potent as one fired from a two and one-half million dollar boat. These small boats could be located at five different points on our coast, and the chances are that at least two of these smaller boats could reach an objective point on the coast line under their protection in shorter time than one large high-speed boat would be able to do. At the same cost they could cover the same area of coast line to a much

better advantage, as there would be five of them distributed over that area instead of one.

Vessels for coast defense should, in my judgment, be equipped to fire torpedoes in any desired direction while submerged. The *Seal*, or G-1, has been the only vessel thus far equipped with torpedoes which could be trained and fired to either broadside. The advantage of this lies in the fact that the vessel can lie at rest with only her periscope extending above the surface of the water. If the vessel is at rest, this periscope can be seen only at a very short distance, while if under way the periscope makes a white "wake" which betrays the presence of the submarine.

We will assume for purposes of illustration that the Sandy Hook entrance to New York harbor is to be defended. If we strike a 15-mile radius from Sandy Hook point, running from the Long Island to the New Jersey shore, and have four submarines take station on that radius line about 5 miles apart, no ship could pass that radius line without coming within the range of vision of the commander of the submarine, either from his periscope in daylight, or he would be well within the range of hearing of his "submarine ears." The Fessenden oscillators, or microphones, now installed in all submarines, would readily detect the approach of a surface ship or ships.

These instruments have been improved to such an extent that it is now possible to carry on "wireless" conversation under water between one submarine and another for a considerable distance. Communication by the Morse code, or other special codes, may be carried on between submarines up to a distance of several miles. It would be possible for groups of submarines on station, or picket

duty, so to speak, to be in constant communication with shore stations, either by submerged telephone connections, or by wireless. In that way the submarines can be kept in constant touch with the country's scouting fleet of high-speed surface vessels or aeroplanes and immediately be notified of the approach of an enemy's fleet or ship. There is no way in which they can themselves be detected,

circle, they would have to pass the submarines distributed on, say, a 10-mile radius. Three submarines would be able to protect this radius line. A 5-mile radius line might also be established with two submarines, and one located at the entrance. A ship, to enter Sandy Hook, therefore, would have to run the gauntlet of five or six submarines without it being necessary for them to leave their stations.



Fig. 47.—Torpedo Being Fired from the Deck Tubes of the Submarine G-1

This vessel was fitted with two double-barrel torpedo guns, housed in a superimposed superstructure. These four torpedoes could be fired to either broadside. The above photograph shows a torpedo in the act of leaving one of these tubes above water. They may be discharged either above or below the surface.

as far as I am aware, as there is no need to run the machinery of the submarine while lying at rest on picket duty, and it would be impossible for a surface ship or flying machine to detect them, providing a constant watch was kept on the horizon or the heavens through the periscopes.

As the range of the modern Whitehead torpedo is about three miles, no ship could pass between the submarines without passing within torpedo range. However, a commander of a submarine would hardly take a chance of making a hit at such a great distance, and on the enemy being sighted he would leave his station and attempt to intercept her, so as to get a shot at shorter range. If the enemy succeeded in running the gauntlet of the outer

FLEET SUBMARINES

Submarines with high speed will become valuable as commerce destroyers and for carrying on an offensive warfare. To stop wars between maritime countries it will probably be necessary to prevent countries having disagreements from carrying on commerce with any other country until they can agree to agree. Fig. 48 shows a high-speed, sea-keeping, fleet submarine of the Lake type. Its principal characteristics are the same as of the coast defense type except that the buoyant superstructure is increased in height sufficient to form living quarters for the crew when cruising in surface condition.

One of the essentials of a high-speed vessel is high-

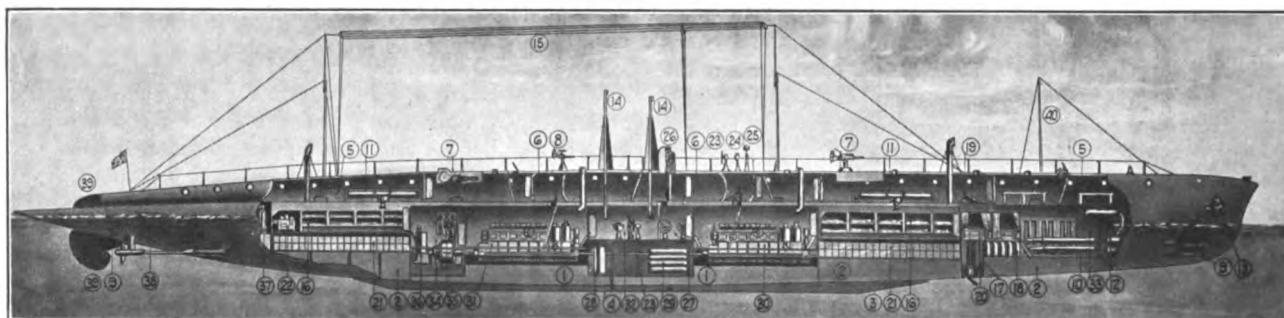


Fig. 48.—A Submarine Cruiser, or Fleet Submarine (Lake Type)

The parts indicated by numbers in this illustration are as follows: 1, main ballast tanks; 2, fuel tanks; 3, keel; 4, safety drop keel; 5, habitable superstructure; 6, escape and safety chambers; 7, disappearing anti-air craft guns; 8, rapid fire gun; 9, torpedo tubes; 10, torpedoes; 11, twin deck torpedo tubes; 12, torpedo firing tank; 13, anchor; 14, periscopes; 15, wireless; 16, crew's quarters; 17, officers' quarters; 18, warhead stowage; 19, torpedo hatch; 20, diving chamber; 21, electric storage battery; 22, galley; 23, steering gear; 24, binnacle; 25, searchlight; 26, conning tower; 27, diving station; 28, control tank; 29, compressed air flasks; 30, forward engine room and engines; 31, after engine room and engines; 32, central control compartment; 33, torpedo room; 34, electric motor room; 35, switchboard; 36, ballast pump; 37, auxiliary machinery room; 38, hydroplane; 39, vertical rudders; 40, signal masts.

powered machinery. A large portion of the interior of the pressure-resisting hull, therefore, must be devoted to machinery space. The high, buoyant superstructure also affords sufficient space below for the crew to rest when entirely submerged; the quarters would necessarily be somewhat cramped without the buoyant superstructure, which gives plenty of room for the crew to take exercise and secure plenty of fresh air when off duty, even in rough water. As it is very important to keep the physical condition of the crew and their spirits in a satisfactory condition, it is essential that they be not kept in restricted quarters for a long period of time.

This vessel is designed to carry torpedoes firing in line with the axes of the ship both fore and aft, and carries, also, torpedo tubes in the superstructure which may be trained to fire to either broadside. Of course such a vessel as this would be fitted with wireless and sound transmitting and detecting devices, and to be effective should have a speed of at least 25 knots, in which case she would be able to pursue and overtake any battle fleet that could be assembled from existing ships in any navy in the world. Undoubtedly such high-speed submarines will come into being within the next few years.

Congress last year appropriated money to build "fleet submarines" in which they expressed the desire to secure 25 knots. A certain amount of discretion, however, was left with the Navy Department, which would permit them to accept boats of not less than 20 knots. There is no difficulty in the way of constructing submarine vessels that will make 25 knots as far as the vessels themselves are concerned. There is no difficulty in the way of making such vessels function satisfactorily when submerged, but up to date no internal combustion engine has been produced suitable for such high-speed submarines, and steam has many disadvantages.

The tactics of the fleet submarine would be to search for and destroy the enemy's warships or commerce carriers wherever they could be found. A sea-going submarine of such character would also carry rapid fire guns of sufficient caliber to destroy surface merchantmen. Having sufficient speed to overhaul them, they would be able to capture the merchantmen and perhaps take them as prizes into their own ports, something which it is impossible for the commander of the small-sized submarines now in commission to do, as they have neither the speed to overhaul swift merchantmen nor guns of sufficient range and power to destroy them if they refuse to follow the instructions of the submarine commander. The only alternative, therefore, has been to destroy the merchantmen and, unfortunately, in many cases, the crew and passengers of the merchant ships have been destroyed as well.

"AMPHIBIOUS" SUBMARINES

From a study of the submarine problem as it stands to-day, the one thing lacking to make the submarine sufficiently powerful to stop commerce on the high seas between countries at war is speed. We have seen from the foregoing that sufficient speed to accomplish this purpose means great additional cost, and as the engine situation exists to-day, it may be considered that it is impossible. My own personal opinion is that we shall not see satisfactory 20-knot submarines, let alone 25-knot submarines, for a matter of three or four years. In the meantime, the people of this country, as well as all other countries not as yet engaged in the gigantic conflict which is taking place across the water, are becoming much exercised as to the possibility of some condition arising which may bring about an attack upon their own country.

There is a method of preparing this country at least

with a type of submarine which may be navigated, so to speak, at much greater speed than that called for by last year's Congress, namely, 25 knots. The boats would have the further advantage in that they would be much less expensive even than the 14-knot submarines now called for in the latest specifications for the coast defense type. This new method calls for the construction of a moderate size submarine which, for the want of a better term to distinguish it, I have called an "amphibious" submarine—that is, a submarine which may be carried on land as well as on or under the water.

These submarines would be somewhat smaller than the present coast defense type of submarine, and of a diameter that could pass through our tunnels and over our

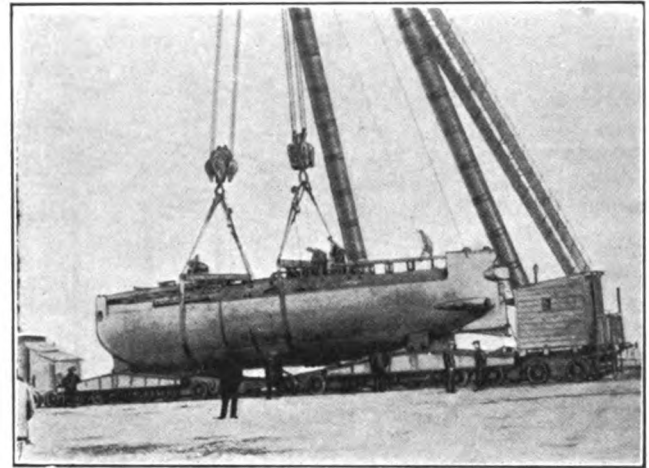


Fig. 49.—"Amphibious" Submarine

Making up a train to ship a Lake submarine across Siberia during the period of the Russian-Japanese war. Note the special trucks with sixteen wheels each, used to carry the load (about 130 tons). As the Trans-Siberian road had light rails, it was necessary to design these special trucks to distribute the weight so as to carry this heavy load. It is remarkable that several of these unheard-of weights should have been transported by vessel and rail a distance of over 10,000 miles each without accident or damage. Boats mounted on trucks especially designed to pass through tunnels could be transported from one port to another at railroad speed and be ready for immediate action in defending threatened sections of the country.

bridges. They could be of about 250 tons submerged displacement. A railroad truck would be provided for each submarine with a sufficient number of wheels to carry the load. The submarine itself would be constructed with proper scantlings to carry her entire load of machinery, batteries, fuel and supplies without injury when mounted on her special trucks. Vessels of this type could be readily constructed that would have a surface speed of 10 to 12 knots and a submerged speed of 10 knots. They could carry as many as eight Whitehead torpedoes and have a radius of action on the surface of about 2,000 miles at 8 knots. Fitted with telescopic, or housing, conning towers and periscopes, nothing would need to be taken apart to ship these submarines from one section of the country to another at railroad speed. Fifty submarines of this type would in time of need probably be more efficient for protecting our thousands of miles of coast line than would many times the same number of 14-knot boats distributed over the same number of miles of coast line.

In the war game no one can tell where the enemy may decide to strike in force. An attack might be made in the vicinity of Boston, New York, Charleston, Pensacola, New Orleans or Galveston on the eastern coast; it might be made at or in the vicinity of San Diego, Los Angeles, San Francisco or Seattle on the western coast. There should be, of course, a certain number of the coast defense type of submarines permanently stationed at these ports

for their protection during war-time periods. But wars come suddenly, and the old saying that "the one who gets in the first blow has the advantage" is a true one. The history of recent wars shows that the declaration of war usually comes after the first blow has been struck. It is readily conceivable, therefore, that before we knew that we were going to become involved in war a fleet of battleships and transports stationed off our harbors, or off a suitable landing place on our extensive coast line, might be able to establish a shore base before we knew it or had time to get sufficient of our slow-going submarines at the danger point to prevent the landing of an invading force.

If we had one hundred submarines distributed over our Atlantic and Pacific coast lines, it would take weeks or months to mobilize many of them at the point of attack,

government made arrangements with the railroads to run a track down under the water at each railroad coast terminal, or to run special tracks into the water at other suitable localities along the coast where there would be sufficient water to float a submarine, submarines could be rapidly mobilized to ward off a landing at any point.

Assume, to illustrate the point which I wish to make, that this country should become involved in war with nations lying both to the east and west of us. To get submarines from one coast to the other would require a long period of time. The "amphibious" submarine, on the contrary, could in an hour's notice be run onto the tracks at New York and three days later be run into the water at San Francisco, with her crew, fuel, stores and torpedoes all ready to go into action at once.

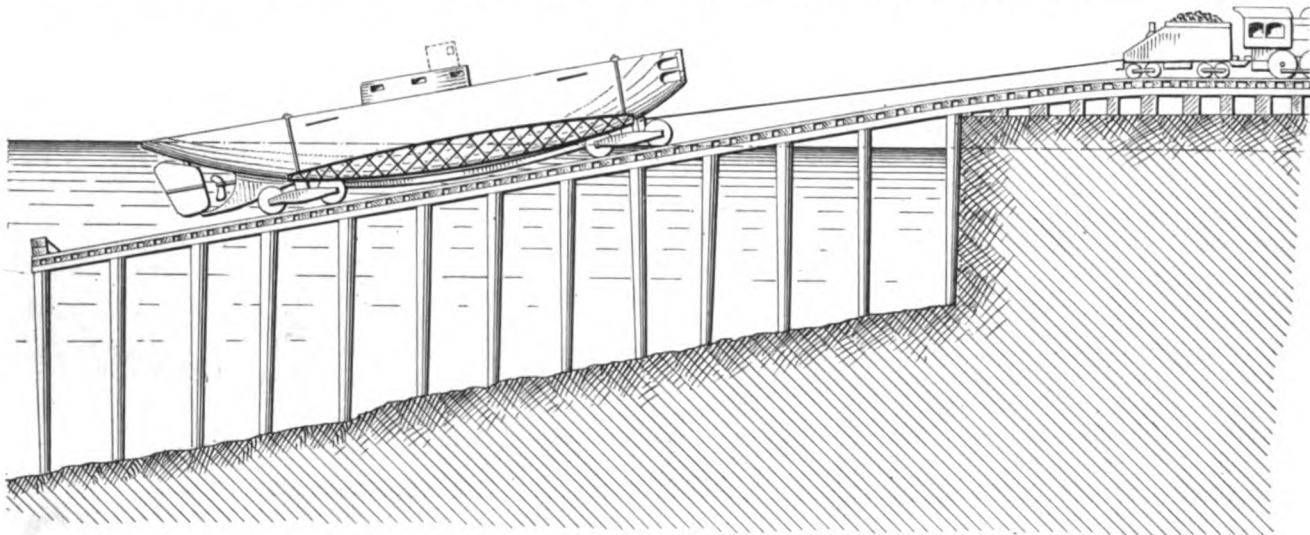


Fig. 50.—Hauling an "Amphibious" Submarine Out of the Water for Transportation Across Country

If the Government were to make arrangements with railroads to carry their tracks down under water, as indicated in the above diagram, special trucks could be built to carry submarines across country. It would be practical to build submarines of a size that would pass through railroad tunnels when mounted as above indicated, that would have a surface speed of 10 to 12 knots and a submerged speed of 10 knots, which would be ample for defense purposes. Such boats could carry eight Whitehead torpedoes and have a radius of action on the surface of about 2,000 miles. Fitted with telescopic conning tower and periscope, nothing would need to be taken apart for shipment by rail. On receipt of word that any particular section of the country was threatened, the "amphibious" submarines could be run on to their railroad trucks and within an hour after the word was received be on their way at railroad speed to the threatened locality.

for the reason that a submarine when submerged has such a small radius of action. The best in the service to-day have a radius of action of about 100 miles at 5 knots, or 11 miles at $10\frac{1}{2}$ knots, or 24 miles at 8 knots. The enemy, with light, shallow draft, high-speed picket boats, could probably make it very unsafe for a submarine to travel any considerable distance along the coast in the daytime, or even at night, in surface cruising condition; and as it takes considerable time to charge the batteries to enable the boat to run in a submerged condition, if the enemy had control of the surface of the sea the average speed per day of a submarine would probably be less than 100 miles without running a grave risk of being captured while in the surface condition. The chances are, therefore, that if we had one hundred submarines distributed over our Atlantic and Pacific coast lines, not over ten or a dozen of them would be able to reach the point of attack in time to prevent the landing of an invading force with sufficient men, guns and ammunition to do a great deal of harm in some of the thickly populated sections of the country before our own citizens could be trained and provided with sufficient arms, ammunition, etc., to retake possession.

If, however, the country was provided with fifty "amphibious" submarines located at ten of our important Atlantic and Pacific ports, they all could be mobilized at an objective point within a week. If the

A submarine could make a trip from Boston to New York in five hours, or from Boston to New Orleans in thirty-five hours. These boats could be built in quantities at a cost of about \$300,000 (£61,500) each. Fifty of them could, therefore, be built at approximately the cost of one modern battleship.

"BABY" SUBMARINES

There has been much talk recently about the so-called "baby" submarines—little one- or two-man boats.

A large number of one-man submarines were built for the Russian Government previous to 1880 by Mons. Dziewieckie, the well-known inventor of the Dziewieckie type of torpedo-launching apparatus. Mr. Holland, Goubet and practically all inventors and builders of submarines commenced with "baby" submarines. One of the designs which I submitted to the United States Government in 1901 called for a one-man boat to be carried on the davits of a battleship or cruiser.

A boat of that kind might have had a place a number of years ago when attacking vessels came near the shore. Such small craft must necessarily have a very limited range of action and very slow speed; they also would be unseaworthy. It would be impossible for a man to remain submerged in a vessel of this type for a considerable length of time, so that, personally, I can see very little use for them at the present time.

(To be continued.)

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Engine-Room Floors

The modern steamer, while in many respects an improvement in equipment and comfort over those of a former epoch, leaves still some opportunity for minor improvements.

The usual engine-room floor to-day consists of chequer plating, and in drawing attention to the matter it is hoped that ship designers will give attention to an older expedient more comfortable to the engine-room staff.

Chequer plates are treacherous when rough weather is experienced. When of mild steel they polish readily by wear, and this, in combination with an eternally greasy condition, causes the unfortunate engineer to slither instead of walk from point to point on watch. Wrought iron chequer plates are not so bad as steel, while by no means a comfortable foothold. In the boiler room the grit of the coal and ash gives a more secure footing. As an example of the superiority of wrought iron, it is only necessary to cite the instances of horseshoes and boot tips, for both of which mild steel is barred from its dangerous tendency to polish.

For this reason of polish, mild steel chequer plates should be rigidly barred for engine-room floors. It is also desirable that such plates should be delivered uncoiled. Accidents directly attributable to coating with boiled linseed oil as a protection against rust by the maker have occurred with newly laid floor plates.

Undoubtedly the most comfortable flooring under the conditions of greasy surface and heavy weather is sheet lead. Carefully treated, it is virtually indestructible; it possesses a substantial value as scrap metal if discarded at any time. It is impenetrable to damp and vermin. Sheet lead has a peculiar value as a roofing material, while its virtues under the conditions indicated are not so well known as they might be.

The underlying wood platform should be carefully laid, all joints smoothed down. Copper scupper nails fix it securely, and artistic ability can pattern these in a pleasing manner.

It can be cut and fitted with an ordinary pocket knife as easily as linoleum or oilcloth.

Lead sheet is manufactured not by wire gage, but as pounds per square foot, and a thickness of 8 pounds per square foot (a scant $\frac{1}{8}$ inch) is sufficient for a floor. It is procurable in any width up to 8 feet wide and 40 to 50 feet in length. It can therefore be plotted to avoid undue waste in cutting up. The only drawback to a sheet-lead floor is its tendency to cut if mishandled or unfairly used.

The writer remembers a vivid, not to say lurid, interview with his chief when, owing to misadventure, a main bearing cap was slewed round on the platform, making a cut in a prominent place.

The rule was to deposit such articles when overhauling on a mat or rivet bag to save damage. By the way, it is remarkable how easily a large weight can be handled, deposited on a coir mat. The mat makes a sliding piece

under the weight and enables quite heavy articles manageable by one man.

This particular floor of eight pounds of lead had been in existence for fifteen years, and during that time had been taken up twice for extensive repairs to the pipes and framing beneath the platform. The lead sheet, in spite of this, was in good condition and apparently of original thickness, while its non-slipping properties in a seaway have left grateful memories.

From experience, the writer can testify to its merits as the finest floor covering extant where grease and motion are plentiful.

A. L. HAAS.

London.

Removing a Rivet from Ship's Bottom Plating

Eleven years ago, while at sea as a junior engineer, the vessel I was on ran into a considerable head sea. She was trimming by the stern at the time, and this, coupled with the fact that the ship had very full lines forward, tended to make the pounding severe on the forward part of the vessel's bottom. The forward hold was only partly filled with cargo, so, when more water than usual was noticed in the bilges, an inspection was readily made and a leaking seam and loose rivet of the shell plating were found.

The seam was successfully calked, but not so with the rivet, which was very much loosened. By attempting to calk the head of this rivet with the calking tool and hammer, other rivets were started, due no doubt to the fact that the water pressure on the outside communicated the shock of the hammer to other rivets in the vicinity, just as attempting to calk a boiler under pressure might do. Finally, with careful and light calking, all but the one rivet were made tight.

After reaching port, and while discharging cargo, this rivet received attention. I heard it was the intention to replace the defective rivet, and thought it would mean going into dry dock. But, without docking and without a diver, the rivet was replaced with a bolt nutted on the inside of the ship as follows:

One end of a stout fishing line about 35 feet long was tied to and wound lengthwise on a small wooden reel about $\frac{5}{8}$ inch wide by $\frac{1}{8}$ inch thick and about 6 inches long, the other end of the line being made fast inside the ship near the rivet. When all was ready, the defective rivet was backed out (overboard), and the reel with line wound on was shoved through the hole and allowed to float up to the surface, unwinding as it went. From a boat alongside the reel was picked up and the end of the fishing line made fast to the threaded shank of a $\frac{3}{4}$ -inch bolt. Then the line was hauled from below (inside the ship) and the bolt entered into the hole, where it was held while the fishing line was removed and a washer and grommet and nut were put on and set up hard. This latter was comparatively easy, as the bolt was long and threaded the whole length.

In fact, the whole job seemed quick and easy, except the wetting of those below, who had it impressed upon them what a lot of water can come through a small hole in the bottom of a ship.

WILLIAM S. OWEN.

Webb's Academy of Naval Architecture, New York City.

The Oldest Steamboat in the World

The photographs shown below may be of interest to readers of INTERNATIONAL MARINE ENGINEERING as they show a group of old-time steamboats, a rapidly disappearing type. These vessels were tied up at Rondout, N. Y. In the foreground of Fig. 1 is the *Norwich*, the oldest



Fig. 1.—S. S. *Norwich*



Fig. 2.—S. S. *Oswego*

steamboat in the world. Astern of her is the *Oswego*, the next oldest steamboat, while in the background is the famous *Mary Powell*, long known as the "Queen of the Hudson." Fig. 2 also gives an excellent view of the *Oswego*. C. D. DAVIS.

Worcester, Mass.

Peculiar Accident to Circulating Pump

A somewhat peculiar accident happened recently to our circulator. Soon after getting under way one night the condenser heated up suddenly, and it was necessary to put on the fire pump to maintain any vacuum at all, and, as the fire pump was entirely too small to furnish enough condensing water, we had to run slow while we investigated the trouble. Our first conclusion was that the strainer over the injection valves had become choked with grease, but, after thoroughly blowing them out and getting no better results, we stopped long enough to remove some of the hand hole plates from the condenser head, but found no obstruction there. This left nothing else to do but to examine the impeller and shaft.

Fortunately, the design of this pump was such that the forward bearing and stuffing box could be removed easily (which is a very good thing and by no means universal with pumps of this kind). This gave us access to the hub of the impeller and we found that the key was gone. This was strange, because the hub of the impeller was long

enough to just clear and turn fully between the bottoms of the stuffing boxes, being $6\frac{3}{4}$ inches long with an open space of about 2 inches in the center, so that it was impossible for the key to get out except by breaking into at least three pieces and working out at the center, one piece at a time. But the keyway showed no sign of the key having become loose, as it necessarily would have done had that been the case. The key could not have become loose and broken in three pieces and finally worked out in the manner described without damaging the keyway enough to at least leave some visible evidence of that having occurred. The keyway was as smooth and clean-cut as when new.

The only plausible explanation of the disappearance of the key is that probably a steel key was fitted when the pump was built (it was then about four years old), and, as it corroded, it became even tighter in the keyway where it was fitted, and, as there was not much of a load on it, it probably did not let go till it became thoroughly disintegrated, and when the impeller finally slipped the key went all to pieces, which would account for its disappearance. Of course, it is not likely that the designer specified a steel key for this bronze impeller and shaft, but occasionally the designer proposes and the mechanic disposes in minor details that are not subject to particularly close inspection.

The key was a rectangular section $\frac{9}{16}$ inch by $\frac{15}{16}$ inch, and we had some cold-rolled steel in the storeroom $\frac{1}{2}$ inch by $1\frac{1}{4}$ inches, so we cut off a piece of that and split a piece off the side with a hack saw, making it $\frac{1}{2}$ by $\frac{3}{8}$ inch, and slipped it in place and went on at full speed, after losing about an hour. Next day in port we fitted a forged bronze key, and have had no further trouble with it.

Norfolk, Va.

D. SAWYER.

Electric and Oxy-Acetylene Welding

The welding process of repairing boilers has made rapid advancement during the past three years. It has unquestionably solved some problems of repairing boilers in an inexpensive and satisfactory manner, but there still remains the fact that in many cases work attempted by this process has proved a failure. Most of the failures, however, are due to the lack of knowledge of the effects of the electric arc and the flame of the oxy-acetylene torch by the operator. Both skill in applying the process and knowledge of the effects are absolutely necessary for the successful operation of this process.

The larger concerns who do this kind of work employ only skilled operators, but there are many smaller concerns who do not have sufficient work of this kind to make it profitable enough to pay the high wages commanded by skilled men, the result being that many times work is done that should not have been attempted. The writer has seen some of these instances and hopes that a description of them will be of benefit to the practical operating engineer.

The side sheets in the furnaces of a leg boiler in a tugboat had cracked between the staybolts in several places and it was decided by the concern which owned the boat to have the cracks repaired by the welding process. A firm which had authority to use this process on marine work was communicated with and one of their representatives stated, after examining the boiler, that it could be satisfactorily repaired by the oxy-acetylene welding process, the kind used by them. They sent one of their operators with appliances for doing the work and he began operations on a crack that extended from a staybolt hole

for a distance of three inches when he began. Before he had done much welding the crack had extended to the next staybolt hole. When he had welded this crack its entire length he discovered that a new crack had started between two staybolt holes two feet away from the one he was working on. He welded the new crack and found that this had started another crack between two other staybolt holes. The same result took place when this crack was welded and the operator became discouraged, as did the superintendent of the concern who owned the boat.

A telegram brought on the next train another representative of the firm which had contracted to do the work, and he took charge of the work. Being an expert in this kind of work he soon discovered that the oxy-acetylene welding process would not successfully repair cracks in side sheets that had become extremely brittle by reason of crystallization. A few cuts with a hammer and cold chisel revealed the brittleness of these sheets, and had this expert examined the boiler the first time he would not have undertaken the job. The old sheets were cut out and replaced with new material.

In another case the top of the back ends of two corrugated furnaces in a Scotch boiler had cracked out from the rivet holes to the edge of the furnaces. These ends were cut off all the way around and the furnaces lengthened on the front ends by riveting pieces on them and then drilling new holes in the back ends and refastening them in place. In a short time they again cracked in the top of the back ends where the flame of the fires struck. A firm which did repair work by the electric welding process claimed that the cracks could be repaired by their process and were given the job. When it was completed there was at least one-half inch of material welded on the top of the back ends of the furnaces, extending in over the rivets. With two thicknesses of metal—the flanges of the flue sheets and the furnaces—and this addition of welded material, between the fire and water there could only be failure, and the welded ends of the furnaces soon burned, leaking worse than ever and had to be replaced with new ones. Only a person who lacked knowledge of the effects of fire on metal would have undertaken to do this job in this manner. Undoubtedly these cracks could have been welded by cutting them V-shaped and then filling up the V's level with the sheet.

Another instance of the lack of knowledge of the effects of the heat of the electric arc on the material on which it was being used occurred on a pleasure steamer. This yacht was constructed of steel and the plates of the hull were of extremely light material. These plates had corroded in places under deadlights, toilets and bath tubs, and it was thought that they could be reinforced in these places, which were not of very great area, by the welding process. This opinion was confirmed by a representative of a firm who did this work and he was given the job. When he had completed the reinforcing of the first spot the plate he was working on had wrinkles in it between the frames that surprised the operator and horrified the owner of the yacht. The operator had no knowledge of the effects of the heat of the electric arc on light steel plates.

It was then decided to cut out the portions of the plates that were deteriorated. This was attempted by the use of the electric arc, but this also proved a failure. The edges of the plates when cut were too uneven to calk and required chipping. On starting to do this it was found that the material had hardened so much that it was a slow and expensive job to chip the edges and the use of the electric arc was abandoned.

None of these jobs would have been attempted had an expert in the use of the welding process been in charge of the jobs in the first instance, and these failures prove that this work should not be entrusted to any but experts.

New London, Conn.

J. S.

Forced Feed Lubrication Aboard Ship

From extensive inquiry, the consensus of opinion is that successful practice in the use of oil comes from unceasing care in handling. Reliable dealers when they sell an oil for a certain purpose are very certain that it will fulfil that purpose and are very glad to aid in any way they can. They have in their employment the best chemists and practical engineers available. They spend thousands of dollars yearly, and their success as oil distributors depends upon the successful operation of the oil they sell. So it is reasonable to assume that when an oil apparently does not do its work the method of application and not the oil is at fault.

Faults may be inherent of the installation or, what is more probable, of the care and handling. The object of the installation is to (1) supply the requisite amount of oil to the desired bearings in varying amounts as demanded; (2) to supply it at the desired temperature—this includes heating and cooling apparatus; (3) to allow sufficient storage; (4) to provide a method for purification, the removal of sediment and water, it being safe to assume that no system is so perfect as to discount these two items.

The amount of supply is a matter of pipe and pump design. There is little choice in the pumps on the market, the ordinary plunger type is very good. For small installations the gear pump is excellent. Pipe diameter must be sufficient to allow a generous supply and to keep the velocity below the critical point. Sharp bends must be guarded against. In laying out the piping it will be found of much value to have a slightly curved section in preference to a straight section, so that when setting up sections this curve will allow the joints to be well made. Ground flange faces, while initially expensive, are cheaper in the long run. The suction lines must be above the highest possible level of bilge water, otherwise a leaky joint on the suction line will fill the system with dirty bilge water.

Heating coils are unnecessary on ships. With the engine room temperature varying very little, it is hard even to imagine a possible condition where they are necessary, except for ships operating in high latitudes. They may aid in settling, but not to such an extent as to authorize their installation on account of the cost, liability of leaks, increased weight and inconvenience in cleaning the tanks. Cooling coils should never be installed in a tank. Use an oil cooler; it is more efficient and leaves the tanks free for cleaning. Many oil tanks are not properly cleaned because of the mass of piping installed in them.

The supply tank must be of sufficient capacity to insure a generous supply. There are many rules. The best practice is to copy a successful installation. The tank should have at least a capacity equal to one-tenth of the hourly supply pumped through the system. Oil can be used over and over for periods varying from six months to a year, if properly filtered and cared for. The tank must be of sufficient size to fill the system and then have an available supply of from 50 to 100 gallons, depending on the size of the installation. In a large installation, as a battleship, there must be at least 100 gallons available. Knowing rate of supply, keep at least two minutes' supply available, as it will take at least this time to shift connections.

The tank must have three connections: (1) supply (this should be at the top); (2) suction (water and sediment

settles to the bottom, so this connection must be above the highest possible water level; in a 400-gallon tank this water deposit may run as high as 40 gallons; (3) drain pipe to run water off (this must be at the bottom and lead to the bilges). The matter of cruising supply is often neglected. Oil will keep indefinitely, hence no loss results from deterioration or other loss attendant to keeping from 500 to 1,000 gallons on hand. A small leak will eat up 200 or 300 gallons in less time than it takes to tell about it. As a minimum in a large installation there should be a reserve of at least 500 gallons. This entails an investment of about \$75 (15/12/6). Ordinarily, when cruising, the make-up oil should not exceed 2 gallons a day.

To illustrate the necessity of supply I will quote an incident that happened to me several years ago. While in charge of a turbine installation of about 10,000 horsepower, a leak developed in a spring bearing. The result was an hourly loss of 20 gallons. The ship had to keep going, and luckily we were carrying a reserve of 500 gallons, due to previous experience. It might also be stated that this reserve was being carried at considerable inconvenience. Previous to this a sister ship had made port on a mixture of water, gasoline (petrol), pump oil, cylinder oil and graphite, the use of said mixture causing several weeks' work. A reserve of 500 gallons in this case would surely have been a saving. Anyone who has spent a day working around oil lines will appreciate this in all its beauties.

Next comes the filtering system with its many troubles. Oil filters are like the measles, we don't like them but we have to have them, and once you have them they are a constant source of irritation, and unless properly treated leave bad after effects. To begin with, most oil filters are too small. Very much like three deuces, they give you confidence, but you don't brag about them. The oil must have time to filter. If sent through too rapidly, the filters are useless. The filter must be cleaned regularly, at least weekly, and oftener if possible. There are examples where the filters have not been opened for months and the operator in the meantime has been yelling about the poor oil the distributors supply, when in reality the oil was excellent and he was only showing up himself. A dirty filter will contaminate the best of oil. If your oil is gradually becoming contaminated, try your filter and it is a good bet that the trouble is there.

The following is a method that I have found to be good in keeping an eye on the oil. Every three or four days take a pint bottle and fill it from the tank in use. Allow it to settle and the water and sediment will collect at the bottom. Any increase in contamination will be discovered at once.

If you wish to go into the subject still more, the following is recommended. Upon request the distributors will supply to you a neat case containing a sample of each oil that you have in use. When the oil is received, compare it with the standard sample as regards color, odor and general characteristics and satisfy yourself that you have received the proper oil. Now each oil has a characteristic color and odor that after a little practice can be easily recognized. As the oil continues in use the color changes, and as a rule the oil gradually becomes darker. To one unfamiliar with oils it may seem to indicate that your oil is going bad, but this is not so. To satisfy this fear try the following method: When the oil is received fill a small bottle, lay it aside and mark this No. 1, with the name of the oil and the date; two weeks later remove another sample, mark this No. 2, noting the date. You will notice that No. 2 is darker than No. 1. Remove about five of these samples and you will notice that Nos. 4 and 5 show little change in color. These five samples will give you a good line on the manner in which the oil should change color

and will give you a color scale for reference with future oil of the same kind.

The oil, while darker, should in all cases be clear; if cloudy, the chances are that water is present in excessive quantities. As regards odor, not much can be said. This is a matter of practice and experience except that water gives the oil a stale, rank odor that is easily recognized. The above-mentioned samples are also of great help in the determination of the amount of water and sediment present.

One of the principal sources of contamination aboard ship is foreign oil. Now this sounds foolish, but, believe me, it is very often sad, as mixing a compound oil with a straight oil is very much like using turpentine instead of olive oil. If you don't believe it, just try it—yes, I mean both. The favorite way for this foreign oil to get in the system is via the rod glands. All cylinder oils leave more or less deposit, and as steam blows through, this deposit is blown down the rod and sooner or later finds its way to the crank pit, and from there into the supply tank. This sounds "fishy," but some day, when the rest of the gang is scrubbing the anchor, sit down (though real engineers are not supposed to do this) and figure out how many times your piston rods travel up and down during six months. And if you should have the misfortune to get an oil mixture you will think that Sherman was talking of oil systems and not of war.

Well, to go back to our filters, the data on filtration are limited, and what really good data there are can only be obtained from the distributors. And let me say right here that they are always willing to help you and in most cases will send a representative upon request. This fact is either little known or often neglected and I most earnestly advise anyone who has troubles to take them to your distributor, and in this way save time and money and at the same time give their oil a fair show.

Oil troubles aboard ship are many and to go into detail would take many pages, but there is one more that I would like to mention, and that is water in the oil. Water aboard ship is always a proposition, and we all acknowledge that the captain uses enough daily to supply make-up feed for a week, but when it comes to getting it in the oil system, well, it is plain, ordinary h—. And the worst of it is that you can't keep it out. Its effect on the system is the same as the effect of the mule on the fellow who twisted his tail—hospital. Oil as received will contain in the vicinity of 1 percent water. On board ship it will collect from 5 to 10 percent water. If it goes over five percent, an investigation should be started. The best way to nip it in the bud is to use the sample bottles mentioned above. Notice how strong I am for those sample bottles. Just try them and you will be, too. The water and sediment settle to the bottom and any increase will be noticed at once. You can get action before there is anything except water in your system and the journals begin to show pit holes big enough to tap.

What has been said above applies to all ship installations in general. Specific cases require their own analyzing. In experience with various installations, large turbines, high speed generators, large and small reciprocating engines, the points mentioned have been found to be quite general. In addition there are many other points as regards viscosity, flash point, etc., that come under the chemical end and need not be considered here, but which are nevertheless very important. Oil troubles aboard ship are, in nine cases out of ten, due to water and poor filtering conditions. In other words, out of every ten cases there is one in which the oil may be at fault and nine in which the care and management are at fault. D.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

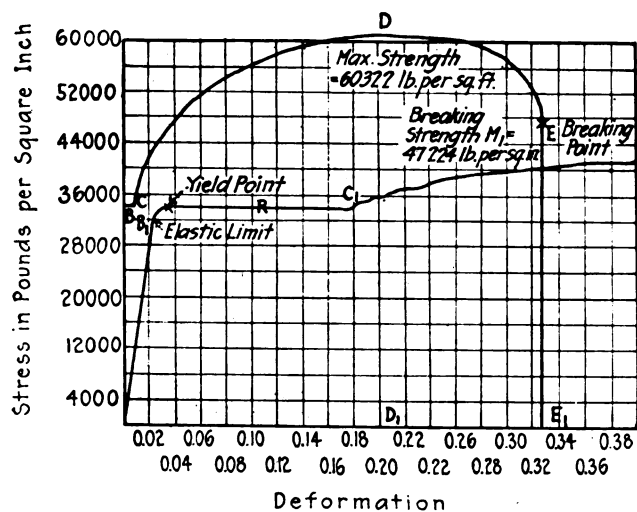
CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Elastic Limit and Yield Point

Q.—Is there any difference between the elastic limit and yield point in testing a specimen by tension? M. T. L.

A.—Properly the elastic limit is the point where the specimen begins to distort at a greater rate than the load increases—i. e., when the ratio of stress to strain departs from a constant value. The yield point is commonly considered as the point at which the weighing beam of the testing machine rather abruptly drops and the specimen



elongates appreciably at constant load. In some materials the points are very close together, but usually the yield point is a bit higher than the elastic limit (see diagram). Curve B C D shows entire test, B-C being the yield point. Curve B₁-C₁ is the early part of the same curve plotted to a much larger horizontal scale, and shows the difference between the elastic limit at B₂ and the yield point much more clearly.

Critical Temperature

Q.—Will you kindly give me a short and understandable definition of "critical temperature?" I find the term appearing much in works on refrigeration, and, so far as I can interpret the definition, it appears to be that temperature above which you cannot liquefy a gas by compression. C. T. R.

A.—If, in your conception, you interject the word "economically" so that it reads that the critical temperature is that temperature above which you cannot economically

liquefy a gas by compression, you will have a very workable comprehension of it without going into the thermodynamic conception involved. For example, the critical temperature of carbon dioxide (CO₂) is about 31 degrees F., and if we cool the gas to that temperature or lower, it will readily liquefy by the expenditure of a reasonable amount of work per pound of resulting liquid. If, however, we had the gas at a temperature of 48 degrees F. (only 17 degrees higher), it would have required *more than twice* as much work to compress it from the same original volume to the liquid condition, and would have required an enormous final pressure. The great saving in the first method is due simply to the fact that the temperature of the gas being compressed was lowered to or below its critical temperature.

An Indeterminate Question

Q.—Can the following question be worked out without the diameter of the shaft being given: Eccentric, 15 inches diameter, 5-inch throw; move it on shaft 1/2 inch; crank on dead center. How far will it move the valve? J. K.

A.—As given, the question is strictly indeterminate, as the 1/2-inch movement referred to is presumably measured circumferentially on the surface of the shaft, and this distance corresponds to an angular displacement which would be proportional to the radius of the shaft.

Calculations for Size of Boiler

Q.—What is the best method used for figuring the size of boiler required for supplying a fore-and-aft compound engine with cylinders 10 and 20 inches diameter by 14 inches stroke, cutting off at 10 1/2-inch stroke; working pressure of boiler, 160 to 165 pounds; piston speed, 600 feet per minute? Probably natural draft would be used, but would you advise what difference in the size of the boiler it would make if forced draft were applied? Do you consider that a Fitzgibbon type boiler or a submerged tube, vertical type, would answer just as well as a Scotch boiler? H. J. G. McL.

A.—The best method is to determine the probable steam consumption of the engine and provide a boiler with sufficient grate and heating surfaces to supply this steam. This necessitates first a determination of the probable indicated horsepower of the engine. The general formula for mean effective pressure (theoretical) is

$$M. E. P. = p_1 \frac{1}{n} (1 + \log_e n) - p_2$$

where p_1 = boiler pressure,
 n = total number of expansions,
 p_2 = back pressure,

if p_1 = 160 pounds per square inch,

$$n = \frac{10 \times 10 \times \pi \times 14}{5 \times 5 \times \pi \times 10.5} = 5.33,$$

and p_2 = 4 pounds per square inch (assumed),

$$\text{then } M. E. P. = 160 \times \frac{1}{5.33} (1 + \log_e 5.33) - 4,$$

$$= 160 \times \frac{1}{5.33} (1 + 1.6734) - 4,$$

$$= 80.2 - 4 = 76.2 \text{ pounds per square inch.}$$

The ratio of theoretical mean effective pressure to probable mean effective pressure is about .55 for this type of engine, so that the indicated horsepower to be expected is

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

$$\text{I. H. P.} = \frac{\text{M. E. P.} \times \text{Piston Speed} \times \text{Area L. P. Cyl.}}{33,000} = \frac{41.9 \times 600 \times 314}{33,000} = 239.$$

A steam consumption, including auxiliaries, of 25 pounds per horsepower hour is reasonable for this type of engine and gives $239 \times 25 = 6,000$ pounds per hour approximately, as the evaporation of the boiler. The equivalent evaporation from and at 212 degrees is

$$\frac{\text{Heat contents at 165 pounds} \times 6,000}{\text{Heat contents at 212 degrees}} = \frac{1,196 \times 6,000}{1,150} = 6,200 \text{ pounds approximately.}$$

$$\text{Boiler H. P.} = \frac{6,200}{34.5} = 180.$$

For Scotch boilers about 7 pounds steam per square foot of total heating surface is as much as should be counted on, which would give $6,000 \div 7 = 857$ square feet, and, allowing 35 square feet of heating surface per 1 square foot grate, the required grate area is $857 \div 35 = 24.5$ square feet. Therefore, a Scotch boiler for the given conditions should have about 860 square feet of heating surface and 24.5 square feet of grate area.

If forced draft is used it is probable that the horsepower per square foot of grate area would be about 15, which would give a much smaller boiler.

Unless the weight is prohibitive, the Scotch boiler will probably be most satisfactory.

Reduction of Speed of Vessel Due to Foul Bottom

Q.—Can you tell me approximately what reduction in speed could be attributed to a foul bottom in the case of a vessel 350 feet by 48 feet by 26 feet draft which made a speed on trial of 13 knots? F. B.

A.—The effect of fouling is to increase the skin resistance, and it has recently been shown that very dirty bottoms may readily increase the skin resistance 400 percent. To gage the effect of foulness by the loss of speed is an insensitive standard, as the power varies as the cube or higher power of the speed. For the vessel quoted, probably the frictional resistance would be about 70 percent of the total resistance, so an increase of 400 percent would effect an increase in total resistance to about 300 percent and would reduce the speed about as

$$\frac{13}{\sqrt[3]{3}} = 9$$

or, roughly speaking, to 9 knots. Of course in practice such fouling should be permitted only under exceptional conditions. In cool waters a vessel three or four months from docking may have an increase of frictional resistance of about 200 percent which would correspond to an augmentation of total resistance of about 70 percent, with an approximate reduction in speed to about

$$\frac{13}{\sqrt[3]{1.7}} = 10.9,$$

or 11 knots, approximately.

How to Figure the Coal Consumption per Indicated Horsepower per Hour

Q.—Will you kindly let me know in your next issue how to find out the pounds of coal per indicated horsepower per hour used on a ship? I assume that you have the data necessary. What I want is how to go about working out this problem from beginning to end. R. V.

A.—The data necessary would be taken from daily reports or from trial trips, and are as follows:

Indicator cards from the engine.

Revolutions per minute of engine shafts.

Coal used during the trial.

From the indicator cards and the scales of the springs

used, the mean effective pressures may be determined. In detail, the mean effective pressure of a card is equal to the area (found by planimeter) divided by the length and multiplied by the scale of the spring. The indicated horsepower may then be found from the formula

$$\text{I. H. P.} = \frac{\text{PLAN}}{33,000}$$

where P = mean effective pressure in pounds per square inch,

L = length of stroke in feet,

A = effective area of piston in square inches,

N = number of revolutions per minute.

33,000 foot pounds of work done per minute = one horsepower.

The horsepower for the other end of the cylinder is determined in the same way. The sum of the two gives the total horsepower for the cylinder. Then, knowing the coal used per hour and the total indicated horsepower, the pounds of coal per indicated horsepower per hour may be found.

Shipbuilding and Repair Plant for the Galveston Dry Dock and Construction Company

The Galveston Dry Dock & Construction Company recently secured a site in Galveston, Texas, for the erection of a shipbuilding and repair plant which will be capable of handling repair work for any class of vessels entering the port of Galveston, and also for the construction of vessels of all types up to a length of 300 feet.

The first step toward the establishment of this plant will be the installation of a Crandall railway dry dock suitable for repair work on tugs, sailing vessels and light steam vessels. The construction of this dry dock, which necessitates an outlay of about \$75,000 (£15,400), is rapidly being pushed to completion, and it is expected that the dock will be ready for business early in 1916.

As an important feature of this plant, plans are being prepared for the construction of a modern floating dry dock composed of five sections, with a combined lifting capacity of 8,500 tons. The extreme dimensions will be: Length, 460 feet; width, outside, 110 feet, and width inside of wings, 83 feet. The dock can be submerged to a depth of 22 feet over 4-foot keel blocks. The five sections will each be 80 feet in length, the two end ones being provided with a semi-circular outrigger, or extension, at a radius of 30 feet. A sixth section can also be added if desirable. The pumping system will comprise four 12-inch centrifugal pumps to each section, the combined capacity of the four pumps being about 16,000 gallons per minute. Each pump will be entirely independent of the others, and any one pump can free one entire section from water in case of a breakdown.

Long Voyage of Diesel-Engined Yacht

The yacht *Southwark*, equipped with a Southwark-Harris valveless engine operating on the Diesel principle, sailed from Philadelphia on October 18 for an extended trip to Panama and then up the west coast to Seattle, provided, upon arrival at Panama, the yacht could proceed through the Canal. The yacht is 98 feet long, 16 feet beam and 7 feet depth. The engine uses a common grade of crude or fuel oil and on a recent trip from Philadelphia to New York and return the cost for fuel was \$8.20 ($1/14/2$) and for lubricating oil \$1.84 ($7/8/2$), making a total cost of \$10.04 ($2/1/10/2$). Both the yacht and the engine have been fully described in previous issues of INTERNATIONAL MARINE ENGINEERING.

Marine Articles in the Engineering Press

Dry Docking Facilities in Japan—Lesson from the Lusitania Disaster—A New Lightship and Self-Unloading Freighter

Japanese Dry Docking Facilities.—By E. R. Thompson. This article contains two tables, one giving the particulars of the government's dry docks in Japan and the other the dry docks available for mercantile vessels. For naval purposes there are seventeen docks available, varying in length from 265 to 777 feet. For the merchant marine there are seventeen dry docks available for vessels up to 300 feet long; fifteen for vessels up to 350 feet; eleven for vessels up to 400 feet; seven for vessels up to 450 feet; five for vessels up to 500 feet, and one for vessels up to 700 feet. The number of dry docks at present available seems to be sufficient for the work to be carried out, but the Japanese sea-going trade is rapidly increasing, and in the future a greater number of large dry docks will probably be required. 1,700 words.—*The Shipbuilder*, August.

Solid Fuel from the Technical and Commercial Standpoint.—By A. E. Battle. This paper explains the application of the approximate analysis of coal and the purchase of coal on a calorific basis for marine purposes. The classification of coal is generally based upon the volatile hydrocarbons present. These hydrocarbons greatly influence its burning, its suitability for special purposes and, to a large extent, the design of the fire grate. The commercial varieties of coal are broadly classified under three heads: lignites, bituminous coal and anthracite. The characteristics and qualities of these coals are explained and the marine engineer is urged to obtain a more accurate knowledge of the fuel that he is using, as this, combined with a slight knowledge of practical funnel gas analysis, would lead to better results than are ordinarily obtained. The writer points out that it is not necessary to be a highly skilled chemist to perform an approximate analysis and he describes a simple manner in which the quantity of moisture, hydrocarbons, carbons, ash and sulphur contained in the coal may be determined, and also the calorific value. The author expresses surprise that at least a snap analysis apparatus to test the funnel gases is not fitted even to well-equipped liners; for it is a well-established fact that operating without some scientific control is open to the inroad of losses heavy and difficult to detect. 7 illustrations. 5,500 words.—*Transactions of the Institute of Marine Engineers*, September.

A Lesson from the Lusitania Disaster.—By William Hovgaard. The author examines first the case of the sinking of the *Lusitania* and second the case of what would have happened in the same circumstances to a ship like the *Titanic*, subdivided on the purely transverse system. The results of this investigation lead to the following conclusions: That the number of transverse subdivisions should be considered as fundamental in the design of all vessels, merchant ships as well as warships, simply because longitudinal stability is always much greater than the transverse, and in sea-going ships is certainly about a hundred times as great. That longitudinal subdivision is intrinsically pernicious on account of the small transverse stability of all ordinary vessels, and should be used only when absolutely necessary. That all wing or side compartments, where such must be fitted, should either be so small that their heeling effect when flooded will be negligible, or, if that is impracticable, as may be the case in warships and auxiliary cruisers, they should be in per-

mament connection with corresponding compartments on the other side of the ship, so as to eliminate the heeling effect automatically. Provision may be made, in addition, for pumping water into the side compartments. In pure merchant vessels no side bunkers or other longitudinal compartments of so large volume as to require such needs of compensation should be allowed. 2,000 words.—*Engineering*, September 3.

Some Technical Aspects of Shipbuilding Contracts.—By H. Bocler. This is a continuation of an article begun in the preceding issue, which dealt with the preliminary considerations entailed by direct guarantees or requirements in regard to deadweight and draft, cubic capacity, trim and stability. The present article deals with flotability when damaged, strength, speed and power. It is now usual for purchasers of passenger vessels to specify certain requirements in respect to the number of damaged compartments with which the vessel should be capable of remaining afloat. The minimum requirements in regard to the watertight sub-divisions of passenger vessels have been established by law in conformity with the provision of the recent International Conference on Safety of Life at Sea. To comply with the conference requirements it is first necessary to construct what is termed a curve of floodable length for the ship—that is, a curve showing at any point in the length the maximum percentage of the ship's length, having its center at the point in question, which can be flooded under the definite assumptions formulated in the conference report in regard to freeboard and permeability. In preliminary designing work it is impracticable in many cases to make the lengthy calculations necessary for an exact determination of the curve of floodable length, and investigations into the number and spacing of bulkheads necessary to comply with the conference requirements have presented considerable difficulty. The Bulkhead Committee have, however, in their recent report published a series of standard curves for obtaining curves of floodable lengths which greatly facilitate the application of the conference requirements. If, as is highly desirable, these curves are accepted by the Board of Trade, in so far as local requirements are concerned shipbuilders will be confronted with a comparatively clear issue.

Stipulations may also be made in regard to the important question of stability when damaged—a matter about which the conference report says nothing, but which may be the governing factor in regard to the capability of the ship to remain afloat. When confronted with special requirements in regard to freeboard and stability with certain consecutive series of compartments flooded, the designers' preliminary investigations prior to the conclusion of the contract need only determine that values in excess of the stability requirements can be obtained. There is no need to determine exact values. It is also usually unnecessary to investigate every series of compartments.

Strength as a primary feature in design is concerned only with the structural strength of the ship as a whole, and when a vessel of normal type and size is built in accordance with the rules of one of the registration societies it is not usual to have any specified requirements involving strength calculations. If, in special cases, strength calculations are required, two factors are in-

volved. First, the straining actions, due to the unequal longitudinal distribution of weight and buoyancy, and, second, the amount and distribution of the material in the longitudinal members of the ship's structure which resist these straining actions. The usual procedure for making these calculations is outlined.

Speed is a primary economical factor in ship design, which must, in the first place, be settled by the ship owner to suit the economic considerations of the trade for which the vessel is intended. The only guarantees which can be required are for the fulfilment of the trial trip speed. The question is largely one of reserve boiler power, but allowance has also to be made for weather conditions. Various methods used for estimating power to give designed speeds are outlined briefly. A margin of at least 5 percent above a reasonable estimate of the power would in the majority of cases be allowed for when designing the machinery. 9 illustrations. 4,500 words.—*The Shipbuilder*, August.

New Graving-Dock at Ferrol Dockyard.—In order to place the government establishment at Ferrol in a satisfactory condition for the repair and maintenance of the new Spanish fleet, the Sociedad Española de Construcción Naval has constructed at this dockyard a new graving-dock designed and built under the supervision of Messrs. Sir John Jackson, Ltd. The length of the dock at the level of the keel blocks from the outer caisson stop to the stem is 573 feet 4 inches. The maximum width of the dock at the cope at the entrance is 101 feet 9 inches and on the floor of the dock 68 feet 11 inches. The depth of water on the sill of the entrance at the usual flood tide is 37 feet 1 inch. The dock entrance is formed with a caisson groove in the side walls and floor and an outer stop at the outer end of the entrance, in accordance with the latest British admiralty practice. The caisson has a length of 102 feet, a height of 50 feet $\frac{1}{2}$ inch and a draft in ballast of 21 feet $7\frac{3}{4}$ inches. The raising and lowering of the caisson is carried out automatically by a series of valves which allow the water to flow in or out, as may be necessary. There are no pumping arrangements in connection with the caisson. The pumping station for emptying the dock is situated near the entrance and consists of two 3-foot diameter centrifugal pumps which are capable of emptying the dock in five hours on a falling tide. 13 illustrations. 1,800 words.—*Engineering*, September 3.

Big Self-Unloader Put in Service.—By R. V. Sawhill. A description of the self-unloading limestone-carrying freighter, *W. F. White*, built this year by the American Shipbuilding Company, Lorain, Ohio, for the Limestone Transportation Company. The vessel is 550 feet long overall, 530 feet length on keel, 60 feet breadth, molded, and 31 feet depth molded. Her capacity is 10,000 tons on a 19-foot draft, and she is equipped with a system of conveyors furnished by the Robins Conveying Belt Company, New York, which is designed to unload 1,700 tons an hour. The vessel is of the single deck type, arch girder, steel construction, the cargo hold being divided into three separate compartments. A continuous double hopper extends fore and aft through the cargo space, the cross section of the hopper being in the form of a flattened "W" with an extreme width of 60 feet. A double bottom 4 feet deep is fitted, extending from the engine bulkhead to the collision bulkhead. It is divided by a center keelson and watertight bulkheads into ballast and trimming compartments. The total water ballast capacity is 7,500 tons. There are twenty-nine hatches, 38 feet wide and 9 feet fore and aft, spaced 12 feet centers. The propelling machinery consists of a triple expansion engine with cylinders 25 $\frac{1}{2}$, 41 and 67 inches diameter and 42 inches stroke, developing 1,800 horsepower. To handle the water ballast,

three Warren ballast pumps are installed, one a 14-inch centrifugal and the other two 12-inch by 16-inch by 18-inch horizontal duplex pumps. The air pump of the Edwards type and the bilge and cooler pumps are attached to the main engine. The boiler feed, pony, mate's and sanitary pumps are all furnished by the Warren Steam Pump Company. Steam is supplied at 185 pounds pressure by three Scotch boilers, 13 $\frac{1}{2}$ feet in diameter and 11 feet long, fitted with Ellis & Eaves system of induced draft. The steering gear of the American Shipbuilding Company's direct-connected type is in duplicate. To handle the cables six single-drum mooring engines with 8-inch by 10-inch cylinders were supplied by the American Shipbuilding Company. A 10-inch by 10-inch spur-gear steam windlass was also furnished by the shipbuilding company for handling two 8,000-pound anchors. The electrical equipment consists of two 15-kilowatt direct-connected Engberg generators. The article gives a detailed description of how cargo is unloaded by means of the conveying machinery. The vessel cost \$500,000 (£101,000) and was completed 163 days after the order was placed. The work of constructing the vessel actually represented 134 working days. 8 illustrations. 3,400 words.—*The Marine Review*, October.

The Irish Commissioners' Lightship Petrel.—The lightship *Petrel*, built to the order of the Irish Lights Commissioners by the Dublin Dockyard Company, Ltd., of Dublin, is 102 feet long on the waterline, 24 feet 3 inches breadth molded and 13 feet 4 inches depth molded. There are two decks and six principal watertight compartments. The watertight compartment abaft the engine room is fitted up as an oil room and contains ten large cylindrical oil tanks, each capable of containing 200 gallons of heavy machinery oil from which the engines and light apparatus are supplied. The mooring arrangements consist of two cables each of 220 fathoms of 1 $\frac{3}{4}$ inch open link, each chain handled by a Harfield windlass worked by a compressed air plant as well as by hand. The lantern, located 40 feet above the waterline on a strong steel mast 2 feet in diameter, is 8 feet 6 inches diameter and 10 feet 9 inches high, supplied by Messrs. R. Merrick & Co., of Cork. The source of the light is 35 millimeter oil incandescent mantles. The engine room contains the oil engines, air compressors, air receivers and other appliances in connection with the disphone equipment for the fog signal. The duplicate set of machinery for compressing the air for the fog signal consists of two sets of oil engines each of 12 $\frac{1}{2}$ brake horsepower by Messrs. Richard Hornsby & Sons, Ltd., of Grantham, Dublin. The air compressors are fitted on the same beds as the engines, each unit being capable of delivering 100 cubic feet of free air into the air receivers, this air being compressed to a pressure of 30 pounds per square inch under normal working conditions. The oil is pumped up to the lanterns under a pressure of 60 pounds per square inch. 2 illustrations. 1,500 words.—*The Shipbuilder*, August.

INSTITUTION OF NAVAL ARCHITECTS.—The annual meeting of the Institution of Naval Architects will be held in London on April 12, 13 and 14, 1916.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The thirty-sixth annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, New York City, December 7 to 10. The spring meeting of the society will be held at New Orleans, La., April 11-14. A feature of the December meeting will be special exercises to honor the memory of the late Dr. Frederick W. Taylor, past-president of the society.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements— Recent Launchings—Improved Appliances—Personal Items

The demand for oil tank steamships has long been recognized as the barometer of shipbuilding conditions in the United States, and in the present unprecedented rush for American-built ships the oil companies have been the leaders. Although something like 400,000 tons of oil tank ships have already been ordered from American shipbuilders, present conditions show no signs of a lessening demand for ships of this particular type.

Steamship owners handling bulk and miscellaneous cargoes have also not been slow to take advantage of vacant building slips for new construction, as is evidenced by the wide diversity of orders for new ships recorded in this column during the past few months. To secure early delivery of vessels of large tonnage, however, is becoming an impossibility, for not only is the capacity of existing shipyards taxed for months to come, but the enormous export of steel products from the United States is likely to cause delays in the delivery of shipbuilding materials.

Contracts for New Ships

The Maryland Steel Company, Sparrows Point, Md., has received a contract from the Standard Oil Company of New Jersey, Bayonne, N. J., for two large tank steamships.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Standard Oil Company of New Jersey to build two large tank steamships.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has received a contract to build a 5,000-ton steamship for an unknown company.

The Shell Oil Company, San Francisco, Cal., is reported to have placed an order with the Union Iron Works, San Francisco, Cal., for five large tank steamships.

The Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received a contract from W. R. Grace & Co., New York, to build two steamships of 10,000 tons net register to cost about \$1,000,000 (£205,000) each. These ships will be used between United States Atlantic ports, the west coast of South America and the Pacific ports of the United States.

The Toledo Shipbuilding Company, Toledo, Ohio., has received a contract from the Great Lakes Steamship Company, Cleveland, Ohio, to build a 600-foot steamer to cost about \$450,000 (£92,300).

The Maryland Steel Company, Sparrows Point, Md., has received a contract to build a freight steamship for the Bull Insular Steamship Company, New York. This order is in addition to the three boats already ordered from the Maryland Steel Company by the A. H. Bull Steamship Company.

The American Shipbuilding Company, Cleveland, Ohio, is reported to have received orders for three large steamships in addition to those previously reported. One of these is a 600-foot ore boat for H. S. Oakes, Cleveland, Ohio.

It is also reported that the order which the American Shipbuilding Company has for two bulk freight steamers for a firm in Christiania, Norway, will shortly be increased to six ships, as Norwegian ship brokers are swamped with orders which they are unable to fill in Europe.

As a result of this state of affairs, the Toledo Shipbuilding Company, Toledo, Ohio, has received orders from Norway for four 5,000-ton motor ships for the oil trade.

The Chester Shipbuilding Company, Chester, Pa., will build two turbine steamships for Norwegian owners.

The Union Iron Works, San Francisco, Cal., is reported to have closed a contract to build three steamships for the Japanese trade. It is reported that the Union Iron Works, in addition to the orders already reported for oil tank steamers, will build five steamers for independent oil interests on the Pacific Coast.

The Staten Island Shipbuilding Company, West Brighton, N. Y., has received a contract from the Lehigh Valley Railroad Company, Philadelphia, to build a 109-foot steel tug.

Theodore A. Crane's Sons Company, New York, has received a contract from the Lehigh Valley Railroad Company to build two 10-foot barges.

The American Bridge Company, Pittsburg, Pa., will build seven steel car floats for the Lehigh Valley Railroad Company.

It is reported that the Chilean Government has placed a contract with a Connecticut Shipbuilding firm for five submarine boats to cost about \$500,000 (£102,500) each.

F. S. Bowker, Phippsburg, Me., will build a three-masted schooner for Rogers & Webb, Boston, Mass.

Robert Palmer & Sons Company, Noank, Conn., has received a contract from the Philadelphia & Reading Railroad Company, Philadelphia, Pa., to build six 207-foot coal barges.

The Greenport Basin & Construction Company, Greenport, L. I., is said to have closed a contract with the British Government for the construction of 100 launches, each 60 feet long and with a speed of 27 miles an hour.

The Herreshoff Manufacturing Company, Bristol, R. I., is building a 109-foot auxiliary schooner yacht.

The Great Lakes Engineering Works, Detroit, Mich., has a contract from the Merritt & Chapman Derrick & Wrecking Company, New York, to build a steel ship of Welland Canal size.

The John H. Mathis Company, Camden, N. J., will build two car floats for the Philadelphia & Reading Railway Company, Philadelphia, Pa.

The Lehigh Valley Railroad Company, Philadelphia, Pa., will build a steel tug, 109 feet long, for use in New York harbor.

The Submarine Boat Corporation, Quincy, Mass., has received an order from the Spanish Government to build six more submarines, making a total of fourteen submarine boats to be built by this company for the Spanish Government.

The Submarine Boat Company is also negotiating with another foreign power to build ten submarine boats.

It is reported that the Standard Motor Construction Company, Jersey City, N. J., has just received an order to build two hundred large motor engines.

It is reported that the Canadian Vickers Company, Montreal, Canada, has received an order to build three hundred "submarine chasers" for the British Government. These boats, according to reports, are to be 75 feet long, and to have a surface speed of 20 knots.

The Morse Dry Dock & Repair Company, South Brooklyn, N. Y., has received a contract from the War Depart-

ment, Washington, D. C., to repair the U. S. army transport *Kilpatrick* at a cost of \$34,000 (£6,950).

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., is reported to have received contracts aggregating more than \$1,000,000 (£205,000) for repair work on ships.

Shipyard Expansion and Improvements

The Standard Shipbuilding Corporation has been organized in the State of New York with a paid-up capital of \$3,000,000 (£615,000). Wallace Downey, 8 Bridge street, New York, is the moving spirit in the new company, which

Quincy, Mass., which will build a slip larger than any now in its yard. The new ways will be 138 feet wide and 800 feet long. The Fore River Shipbuilding Corporation now has contracts to build one battleship, three destroyers, twenty-one submarines and nine merchant steamers; the total cost to be nearly \$28,000,000 (£5,750,000), and it is estimated that new buildings and equipment already ordered will cost \$2,000,000 (£410,000).

The New York Shipbuilding Company, Camden, N. J., has begun work on two new ways. The company has on hand contracts to build ships to cost about \$15,000,000 (£3,080,000).

The Lake Torpedo Boat Company, Bridgeport, Conn.,



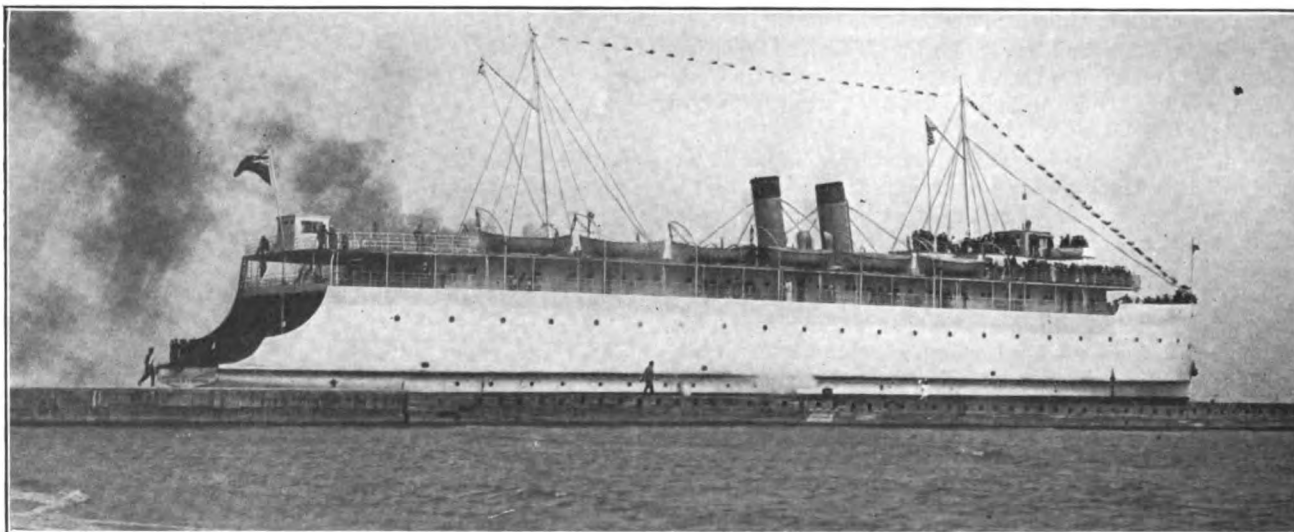
View of the Recent Slide in the Panama Canal, Showing Dredging Operations

has made arrangements to open the shipyard at Shooters Island, New York. It is reported that the company already has offers of contracts amounting to \$8,000,000 (£1,640,000).

Many of the shipyards of the country are being much enlarged so as to be able to handle the unprecedented amount of business now on hand. Among the companies which have recently let contracts for the enlargement of their plants is the Fore River Shipbuilding Corporation,

has bought a large amount of land on which it will build a new yard, so that it will be possible for the company to build torpedo boat destroyers and scout cruisers.

The Morse Dry Dock & Repair Company, Brooklyn, N. Y., is planning to build a sectional floating dry dock of 27,000 tons capacity at the foot of Fifty-eighth street, Brooklyn. This will be the largest dry dock of its type in the United States.



Twin-Screw Car Ferry *Ontario No 2* of 5,400 Gross Tons Built by the Polson Iron Works, Ltd., Toronto, Ont.

Shipbuilding Contracts Pending

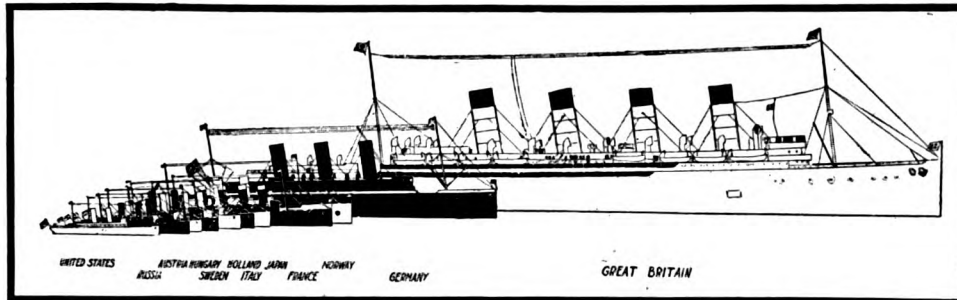
The Pocahontas Navigation Company, New York, which has already placed contracts with the New York Shipbuilding Company, Camden, N. J., for three steamships, will, so it is reported, build a number of additional ships in the future.

Capt. C. W. Jungen, manager of the Atlantic Steamship Lines of the Southern Pacific Company, New York, an-

The Lumber Exporters Line has been organized in Gulfport, Miss., to operate a steamship service to export Southern hard wood lumber to Europe.

The Majestic Steamboat Company has been incorporated in Alexandria, Va.

It is reported that a company to be called the France & Canada Steamship Company, has been organized at Toronto, Canada, with a capital stock of \$1,000,000 (£205,-



Graphic Illustration of the Urgent Need of an American Merchant Marine. The United States Is Eleventh Among the Nations in Ship Tonnage in Foreign Trade

nounces that bids will be called for shortly for two large freight steamships to ply between New York, New Orleans and Galveston.

Messrs. Esplen & Sons, Ltd., New York, are reported to be in the market for ships for account of English steamship concerns, and if satisfactory arrangements can be made will order any number of ships up to fifteen or more.

Messrs. Esplen & Sons, Ltd., are also understood to be in the market for a marine engine of about 1,200 horsepower, with shafting, etc., to install in a ship already built.

The Macon & Atlanta Navigation Company, Macon, Ga., has increased its capital stock to \$200,000 (£41,000) and will, so it is reported, construct additional power barges.

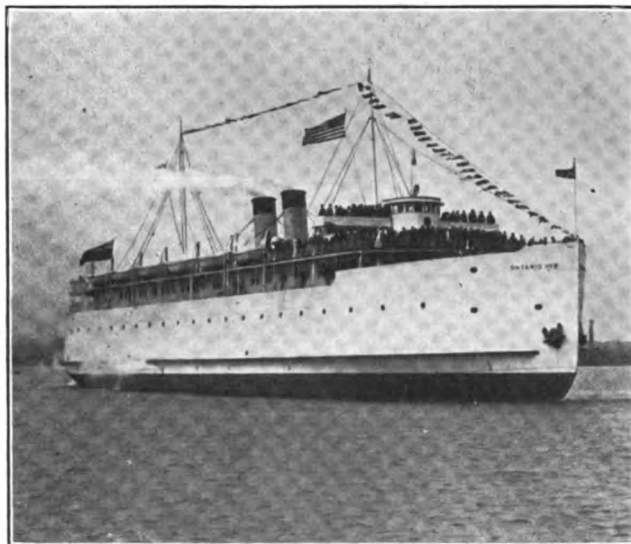
ooo) to inaugurate a steamship service between Canada and France.

Appeal for Larger American Merchant Marine in Foreign Trade

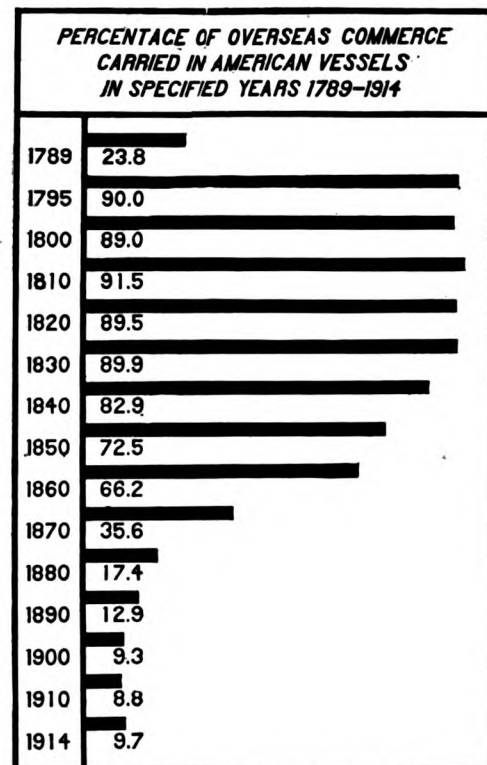
The urgent need of a larger American merchant marine for carrying on the nation's foreign trade is graphically illustrated by the two diagrams which are printed on this page, through the courtesy of the National Marine League. These diagrams show that the United States is eleventh among the maritime nations in ship tonnage in foreign trade, and that less than 10 percent of the over-seas commerce is now carried in American vessels.

New Steamship Lines

The Pacific & Eastern Steamship Company has been incorporated in the State of New York with a capital stock of \$2,000,000 (£410,000). Half of the capital has been subscribed by Americans and half by Chinese. The American interests are represented by F. Mertens' Sons of Cumberland, Md., and Washington, D. C.



Bow View of Ontario No. 2



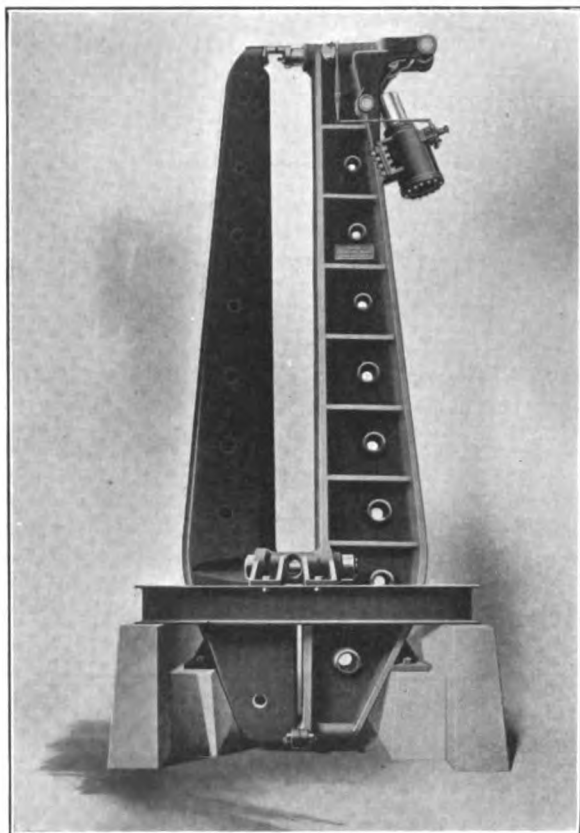
The Reason Why the United States Should Have a Larger Merchant Marine

ENGINEERING SPECIALTIES

Large Pneumatic Riveter

Two of the largest pneumatic riveters ever constructed have just been built by the Hanna Engineering Works, Chicago, Ill. The machines have a reach of 21 feet and are capable of exerting a pressure of 100 tons on the rivet die at 100 pounds air pressure. Each machine weighs 40 tons.

In the Hanna type of riveter toggles, levers and guide links are combined to give the large opening of the toggle joint movement with its gradually increasing pressure



Hanna Pneumatic Riveter, with Reach of 21 Feet

until the desired pressure is reached, then a simple lever movement throughout a considerable space under approximately maximum pressure. This space is sufficient, so that there need be no uncertainty about the pressure applied on the rivet; and the machine once adjusted for a certain length of rivet and thickness of plate, will require no further adjustment for ordinary variations in length of rivets, size of holes, or thickness of plates.

The machines are furnished with cylinders having 22 inches of piston stroke with a relative travel of $5\frac{3}{4}$ inches of the rivet die. The toggle action takes place during the first half of piston travel, which represents approximately the first $4\frac{3}{4}$ inches of die travel. At this point the mechanism automatically changes into a simple lever action, without a critical point, thus producing the rated tonnage of the machine at the rivet die, practically uniform for the last 1 inch of die travel. By the use of a pressure regulating valve in the air supply line to the riveter, the pressure of air at the cylinder can be quickly changed to vary the pressure on the rivet dies to produce any tonnage the operator may deem advisable for any size of rivet he may wish to drive.

An Interesting Test

Recently one of the large steamship companies in the United States submitted two ring life buoys to a 28-hour test—one of solid cork covered with canvas and the other of balsa wood, half of which was covered with canvas. The balsa wood ring buoy is of the type manufactured by the Welin Marine Equipment Company, Long Island City, and known as the A. B. C. ring buoy. It is 30 inches diameter on the outside and 18 inches diameter on the inside. For the comparative test both ring buoys were put overboard into the water and to each was attached a weight of 32 pounds. They were left undisturbed for a period of 28 hours. At the end of this time the cork buoy was almost totally submerged, floating about an inch lower in the water than when first placed in the water. The balsa wood buoy floated apparently the same as when first placed in the water.

An Unusual Yoke Forging

Recent developments in the self-unloading cargo boats on the Great Lakes have made necessary the use of an unusual yoke forging. In the case of the steamship *W. F. White*, which was built this year by the American Shipbuilding Company, at Lorain, O., the vessel was equipped with an unloading mechanism designed to unload her

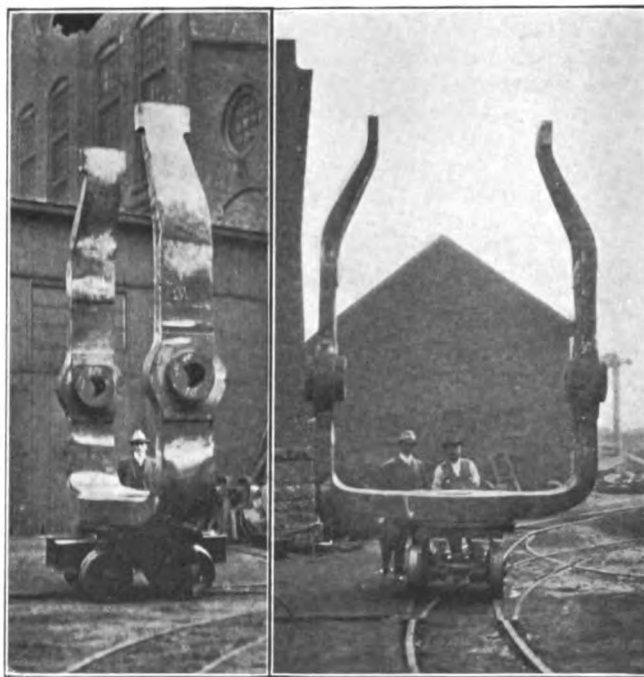


Fig. 1

Fig. 2

cargo of 8,500 tons at the rate of about 2,000 tons per hour. A yoke forging carries a boom, hopper and the machinery operating the main carrier belt, which is driven by an 11-inch shaft. The boom is carried on milled trunnions and will deliver the cargo from the steamer on any dock 150 feet from the centerline of the ship. The yoke forging on this vessel was made by the Delaney Forge & Iron Company, Buffalo, N. Y.

The rough forging weighed 24,000 pounds. Figs. 1 and 2 show the forging bent to shape and ready to ship. The extreme width is 9 feet 11 inches and the extreme height 13 feet 2 inches. The finished weight is 19,500 pounds.

PERSONAL MENTION

Operating Engineers

George S. Kreutzer, of Paducah, Ky., is chief engineer of the river steamer *Hibernia*.

Albert Windfield, of Paducah, Ky., has been appointed engineer on the towboat *Redspot*.

James Shepard, of New Orleans, La., has been appointed first assistant engineer of the steamer *Ponce*.

Anthony Annedo, of New Orleans, La., has been appointed chief engineer of the tug *Wash Gray*.

James Pulaski, of New Orleans, La., has been appointed third assistant engineer of the steamer *Somerset*.

William F. Brookes, of New Orleans, La., has been appointed chief engineer of the steamboat *Florence*.

James L. Yent, of New Orleans, La., has been appointed second assistant engineer of the steamer *San Juan*.

George Richardson, of New Orleans, La., has been appointed chief engineer of the tug *Asher J. Hudson*.

E. L. Milbury, of New Orleans, La., has been appointed second assistant engineer of the steamer *Massapequa*.

A. J. McMillan, of New Orleans, La., has been appointed first assistant engineer of the steamer *Rosalie Mahoney*.

E. S. Mildey, of New Orleans, La., has been appointed second assistant engineer of the steamer *John D. Archbold*.

Ambrose Van Wie has been appointed chief engineer of the tug *Marguerite* at Albany, N. Y., vice Paul Cramer, resigned.

Charles Bortle has resigned as chief engineer of the steamer *William H. Kinch*, of the Great Lakes Dredge & Dock Company, Albany, N. Y.

George B. Langin, chief engineer of the tug *Mary M.*, has been transferred to the tug *Lydia*, of the Miller Dredging Company, Albany, N. Y.

W. D. Hardester, of Paducah, Ky., has been appointed assistant engineer on the river steamer *North Star*. James L. Weston is chief engineer of this vessel.

Frank Beck, of New Orleans, La., has been appointed chief engineer of the tug *Maud Wilmot*. Jacob Huber has been appointed assistant engineer of this tug.

Elsworth B. Mealy has been promoted to the position of chief engineer of the tug *Florence W.*, of the Randerson Dredging Company, stationed at Mechanicsville, N. Y.

Henry Stammell, formerly chief engineer of the tug *Lydia*, at Albany, N. Y., has been appointed chief engineer on the steamer *Paul LeRoux*, which is to be stationed at Waterford, N. Y.

Ed. L. Latham, who has been acting chief engineer of the river steamers *Alabama* and *Kentucky* at Paducah, Ky., has resumed his former position of chief engineer of the river steamer *St. Louis*.

George Smith, chief engineer of the Potomac & Chesapeake Steamboat Company, Washington, D. C., is in New York supervising the overhauling of the steamer *Majestic*, recently purchased by the Potomac & Chesapeake Steamboat Company for the Potomac River route.

William C. Claflin, chief engineer of the tug *Florence W.*, of the Randerson Dredging Company, Mechanicsville, N. Y., has resigned to act as chief engineer of the freight annex steamer *Mary Gordon*, of the Manhattan Navigation Company.

Henry Van Loon, of Athens, N. Y., formerly chief engineer of the passenger steamer *William M. Whitney*, of the Albany & Troy Steamship Company, has been appointed chief engineer of the steamer *William H. Kinch*, of the Great Lakes Dredge & Dock Company, Albany, N. Y.

Naval Architects, Consulting Engineers, Draftsmen and Shipyard and Steamship Officials

W. D. Smith has been elected president of the American Shipbuilding Company, Cleveland, Ohio.

E. H. Howell, formerly in the armor section at the New York Navy Yard, Brooklyn, N. Y., has been placed in charge of the new work section at the yard.

G. R. Martin, formerly assistant to the chief draftsman of the machinery department of the New York Navy Yard, Brooklyn, N. Y., is now with the American Steam Gauge Company, Boston, Mass.

George W. Harney has been appointed supervising inspector of the United States Steamboat Inspection Service at Norfolk, Va., succeeding Colonel John W. Oast, who has resigned after thirty years' service.

Harry S. Lord, for twelve years assistant inspector of the United States Steamboat Inspection Service at Seattle, Wash., was recently appointed inspector of this district, succeeding R. A. Turner, who was killed in an automobile accident.

R. P. Schwerin, who has been general manager of the Pacific Mail Steamship Company since 1891, has been appointed vice-president and general manager of the Associated Oil Company, controlled by the Southern Pacific Company.

W. R. Haynie, manager of Bolinders Company, New York, recently sailed from New York for Stockholm to visit the works of the J. & C. G. Bolinders, Ltd., in order to increase the facilities for delivering marine oil engines in America.

H. C. Fletcher has been appointed chief draftsman in the hull division at the New York Navy Yard, Brooklyn, N. Y. Mr. Fletcher was formerly in charge of the new work section in which the plan work for the new construction is handled.

OBITUARY

Nathan R. Dyer, superintendent of the Portland Shipbuilding Company, Portland, Me., died on October 30.

Michael Ratsey, the veteran yacht designer of Cowles, Isle of Wight, died at Kingston-on-Thames on October 27.

Isaac Leopold Rice died suddenly in New York on November 2, aged sixty-five years. For many years he was president of the Electric Boat Company.

Herbert Barber, president of Barber & Co., Inc., New York, and one of the best known shipping men in the United States, died recently in New York of pneumonia, aged sixty-eight.

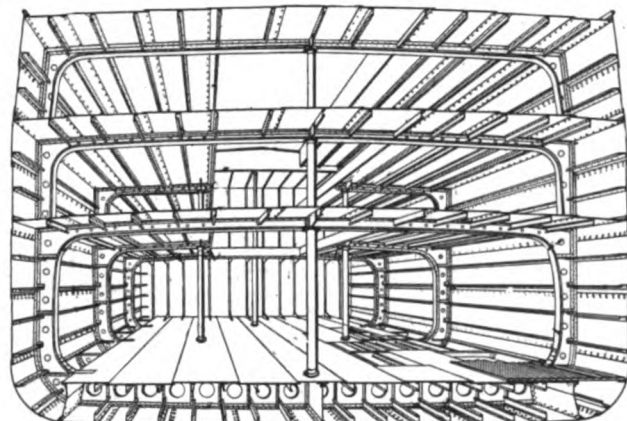
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,147,732. METHOD OF BUILDING LONGITUDINAL-FRAMED VESSELS. JOSEPH WILLIAM ISHERWOOD, OF MIDDLESBROUGH, ENGLAND.

Claim 1.—The method of erecting vessels on the longitudinal system, which consists in first bringing a plurality of the vessel's main longitudinal members in such positions that their outer surfaces will form parts of the outer contour of the vessel's completed framing; then securing to said members a plurality of the vessel's main frames



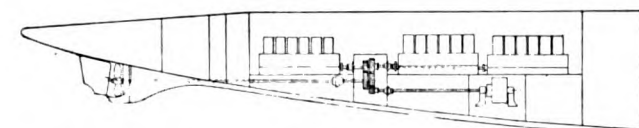
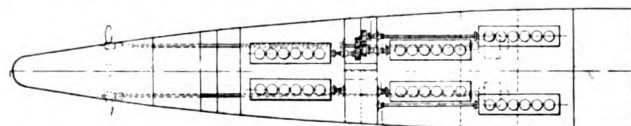
also forming parts of the outer contour of the vessel's framing, and then securing the shell plating of the vessel directly to said transverse and longitudinal members, substantially as described. Six claims.

1,146,059. COLLAPSIBLE LIFEBOAT. HUGO ERNST, OF CAMDEN, N. J.

Claim 1.—A collapsible boat comprising fore and aft keel pieces, a keel strip connected to said pieces, double hinges connected to opposite sides of the keel pieces, outwardly bowed braces connected with the said hinges, a plurality of floor sections hinged to a pair of said braces and having break joints in alignment with the keel, an inflatable buoyant bag located between the floor sections and the keel, a flexible covering without and fixed to the respective keel pieces, keel and braces, and sectional hingedly connected seats pivotally secured to another pair of the braces and having break joints in vertical alignment with the break joints of the floor sections. Two claims.

1,149,373. SUBMARINE BOAT. SIMON LAKE, OF MILFORD, CONN., ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY OF MAINE, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

Claim 3.—In a submarine boat, a gear-room built within the main hull of the boat, a propeller having the inner end of its shaft extended into said gear-room and provided with a gear-wheel, a series of engines



mounted within the boat, each having its power shaft extended into said gear-room and provided with a driving gear, a motor mounted within the boat having its shaft also extended into said gear-room and provided with a driving gear, and means for adjusting said driving gears independently into and out of mesh with the gear-wheel of the propeller shaft. 11 claims.

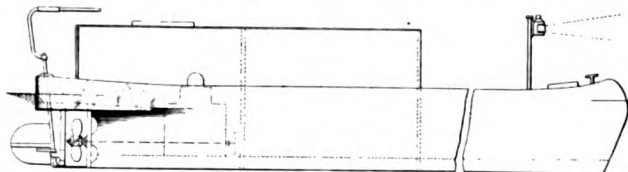
1,131,764. SOUNDER FOR SUBMARINE SIGNALING. ROBERT L. WILLIAMS, OF NEWTON, MASS., ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

Claim 1. A sounder for submarine signaling comprising a liquid-filled tank, two concentric members submerged therein, one member being within the other, the inner member being chambered, each member having ports, the ports of one member being located to register with the ports of the other member, one of said members being adapted to be rotated with relation to the other member, said ports being located on opposite sides of said members whereby when said ports register the pressure within said members will be released in opposite directions. Ten claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

20,243/14. IMPROVEMENTS IN SHALLOW DRAFT BOATS. A. H. WHITE, OF SUFFOLK HOUSE, CANNON STREET, LONDON.

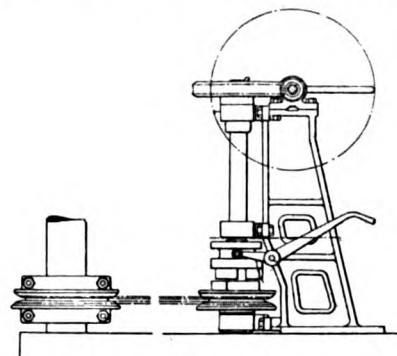
The invention relates to shallow draft boats, such as barges or canal boats, and has for its object to provide a construction of hull which results in the attainment of an increased speed and efficiency, and incidentally a prevention or diminution of wash. The underside of the



counter of the hull of the boat is formed with a ridge or projection, the said ridge extending around the outer edge of the said counter, as the propeller rotates, the water partly comes into contact with the ledge formed by the ridge or projection, and is held or piled up to a sufficient extent to prevent the formation of the partial vacuum, incidentally preventing or greatly diminishing the wash, which is of great value.

24,694/1914. TURNING-GEAR FOR SHIP'S DAVITS. H. LAING AND SIR J. LAING & SONS, LTD., DEPTFORD YARD, SUNDERLAND, DURHAM.

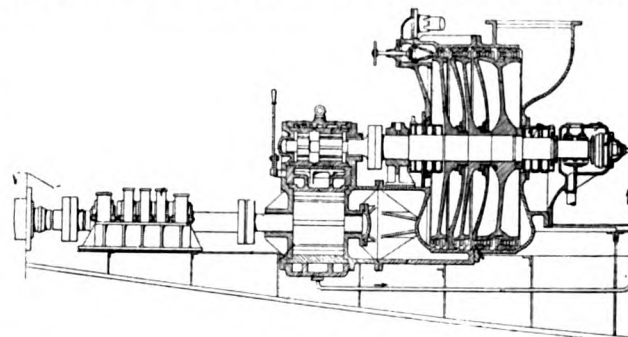
Claim.—According to this invention there is provided a separate turning gear for each davit, each gear comprising a rotated shaft mounted in bearings supported by a frame on the deck of the ship adjacent to



the davit, a chain wheel loosely mounted on said shaft, a chain wheel secured to the stem of the davit, a chain passing around said wheels, and means whereby the chain wheel on the shaft can be clutched thereto when desired so that, by rotating said shaft, the motion thereof will be communicated to the davit to turn same.

21,606/14. A HYDRAULIC TRANSFORMER FOR SHIP PROPULSION BY MEANS OF STEAM TURBINES. H. LENTZ, 18, BORNIMERSTRASSE, BERLIN-HALENSEE, GERMANY.

This invention relates to a device for relieving or balancing the primary shaft in ship propulsion, with a hydraulic transformer inserted between the shaft driven by a steam turbine and the propeller shaft. By means of this transformer the speed of the propeller shaft can be modified, without altering the number of revolutions of the engine shaft. The transformer used is a hydraulic gear, consisting of valveless pumps,



one set of which is driven from the turbine shaft, while the other, or motor set, drives the propeller shaft. The set of pumps mounted on the turbine shaft and the set of motors mounted on the propeller shaft, are arranged to act at one side, and in such a manner, that during the transmission of power within the gear, there is produced a pressure tending to raise the primary shaft so that the latter is completely, or for the most part, balanced. The turbine shaft further balanced in the longitudinal direction by connecting the pressure chamber of the gear by means of a pipe to the end of the steam turbine shaft, which is enclosed at the back in the form of a piston, so that the hydraulic pressure transmitted to that point acts in opposition to the longitudinal thrust produced by the steam pressure.